DISSERTATION ON

OUTCOME ANALYSIS OF QUADRICEPSPLASTY

IN STIFF KNEE

SUBMITTED TO

THE TAMILNADU

DR. M.G.R. MEDICAL UNIVERSITY

CHENNAI, TAMILNADU

In Partial fulfillment of the regulations

for the award of the degree of

M.S. (ORTHOPAEDIC SURGERY)

BRANCH II

MADRAS MEDICAL COLLEGE

CHENNAI -600003

APRIL 2017

CERTIFICATE

This is to certify that this dissertation titled **"Outcome Analysis of Quadricepsplasty in Stiff Knee"** is a bonafide record of work done by **Dr.Gnanavinayagan.S** during the period of his postgraduate study from June 2014 to June 2017 under guidance and supervision in the INSTITUTE OF ORTHOPAEDICS AND TRAUMATOLOGY**,** Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai-600003, in partial fulfillment of the requirement for M.S.ORTHOPAEDIC SURGERY degree examination of The Tamilnadu Dr. M.G.R. Medical University to be held in April 2017.

PROF.N.DEEN MUHAMMAD ISMAIL,
D.Ortho., M.S.Ortho.,
Director I/C
Professor of Orthopaedic surgery,
Institute of Orthopaedics and Traumatology
Madras Medical College and
Rajiv Gandhi Government General Hospital,
Chennai-600003.Tamilnadu.

PROF.V.SINGARAVADIVELU,
M.S.Ortho., Ph.D.,
Professor of Orthopaedic surgery,
Institute of Orthopaedics and Traumatology
Madras Medical College and
Rajiv Gandhi Government General Hospital,
Chennai-600003.Tamilnadu.

Dr.M.K.MURALIDHARAN
MS., M.Ch.Neurosurgery
Dean,
Madras Medical College,
Rajiv Gandhi Govt. General Hospital,
Chennai – 600003

DECLARATION

I declare that the dissertation entitled **"OUTCOME ANALYSIS OF QUADRICEPSPLASTY IN STIFF KNEE"** submitted by me for the degree of M.S is the record work carried out by me during the period of **June 2014 to June 2017** under the guidance of **PROF.V.SINGARAVADIVELU, M.S.ORTHO., PhD.,** Professor of Orthopaedics, Institute of Orthopaedics and Traumatology, Madras Medical College, Chennai. This dissertation is submitted to The Tamilnadu Dr.M.G.R. Medical University, Chennai, in partial fulfillment of the University regulations for the award of degree of M.S.ORTHOPAEDICS (BRANCH-II) examination to be held in April 2017.

Place : Chennai
Date :

Signature of the Candidate

(Dr. Gnanavinayagan.S)

ACKNOWLEDGEMENT

I express my thanks and gratitude to our respected Dean **Prof**. **Dr.M.K.Muralidharan. M.Ch.,** Madras Medical College, Chennai – 3 for having given permission for conducting this study and utilize the clinical materials of this hospital.

My sincere thanks and gratitude to **Prof. Dr.N.Deen Muhammad Ismail, M.S, Ortho., D.Ortho**. Director I/C, Institute of Orthopaedics and Traumatology, for his guidance and constant advice throughout this study.

I have great pleasure in thanking my Guide**, Prof.Dr.V.Singaravadivelu, M.S.Ortho., PhD**. Professor, Institute of Orthopaedics and Traumatology, for his guidance and valuable advice provided throughout this study.

My sincere thanks and gratitude to **Prof.Dr.A.Pandiyaselvan M.S.Ortho., D.Ortho**. Professor, Institute Of Orthopaedics and Traumatology, for his valuable advice and support.

I sincerely thank **Prof.Dr.Nalli R.Uvaraj M.S.Ortho**., **D.Ortho.,** Professor, Institute Of Orthopaedics and Traumatology for his advice, guidance and unrelenting support during the study.

My sincere thanks and gratitude to, P**rof. M. Sudheer M.S. Ortho., D.Ortho.,** Professor, Institute of Orthopaedics and Traumatology, for his constant inspiration and advice throughout the study.

My sincere thanks and gratitude to my co-guide **Assistant Professor Dr.J.Pazhani** for his constant advice and guidance provided throughout this study.

I sincerely thank **Dr.K.Muthukumar, Dr.P.Kinglsy, Dr.G.Hemantha Kumar, Dr.Nalli R.Gopinath, Dr.S.Senthil Sailesh, Dr.P.Kannan, Dr.A.Saravanan, Dr.Mohammed Sameer, Dr.N.Muthalagan, Dr.D.Suresh Anand, Dr.G.Kaliraj, Dr.R.Rajganesh, Dr.A.N.Sarathbabu, Dr.P.R.Dhanasekaran** Assistant Professors of this department for their valuable suggestions and help during this study.

I thank all anaesthesiologists and staff members of the theatre and wards for their endurance during this study.

I am grateful to all my post graduate colleagues for helping in this study. Last but not least, my sincere thanks to my patients, without whom this study would not have been possible.

TABLE OF CONTENTS

S. No	Title	Page No.
1	Introduction	1
2	Aims and objectives	3
3	Applied anatomy	4
4	Review of literature	18
5	Techniques of Quadricepsplasty	27
6	Materials and methods	48
7	Observation and results	54
8	Discussion	63
9	Conclusions	69
10	Case illustrations	70
	Bibliography	81
	Annexures	
	1.Proforma	86
	2. Consent form	88
	3. Judet's criteria	90
	4. Ethical committee Approval	91
	5. Digital Receipt	92
	6. Plagiarism screen shot	93
	7. Master chart	94

Introduction

Extension contracture or stiff knee is a complication of fracture femur and tibia, particularly in the periarticular area. Adequate knee flexion may not be possible, if proper postop rehabilitation was not done . After a fracture in the periarticular area around knee joint, early fixation of fracture and range of motion exercises should be started as early as possible . In most of our cases, stiffness is due to the inadequate mobilization postoperatively leading to fibrosis of rectus femoris, periarticular and intermuscular adhesions which prevent free gliding of the muscle fibres one upon another. The other causes of knee stiffness that are postulated are idiopathic, frequent intramuscular injections in the anterior thigh musculature, congenital short femur who underwent femoral lengthening procedures and congenital. If knee stiffness is severe and not improved by conservative treatment by knee mobilization exercises, the functional range of movement can be increased by doing various methods of quadricepsplasty.

Knee stiffness results in severe locomotor disability and affects the individual as a whole especially in country like India where people sit on floor and squat for various purposes like working in the farms or for toilet.

Management of this condition is mainly surgical except for mild degrees of contractures where flexion of knee is more than 90^0. The technique of releasing the adhesion and contractures in the quadriceps muscle is known as “QUADRICEPSPLASTY”. The management of knee extension contractures may therefore vary from simple arthroscopy to lyse adhesions to more extensive soft tissue release procedures. Quadricepsplasty can be divided into proximal and distal types. Most often the traumatic causes of stiff knee warrents a combined type for better results.

Aims and objectives

To assess the functional outcome and improvement in range of movement from preoperative through peroperative to postoperative range of movement.

Applied anatomy of knee joint

The knee joint is a complex hinge type of synovial joint .

The knee joint consists of three articulations

- Two femorotibial articulations between the lateral femoral , medial femoral and the tibial condyles.
- One intermediate femoropatellar articulation between the patella and the femur.
- The fibula is not involved in the knee joint.

Distal femur

It bears two massive condyles. Anteriorly the condyles are confluent and continues into the shaft; posteriorly they are separated by a deep intercondylar fossa and project beyond the plane of the popliteal surface. Anteriorly distal femur has a patellar surface that helps to stabilise the patella. An abnormally shallow groove predispose to habitual dislocation of patella.

The intercondylar fossa separates the two condyles distally and behind. The lateral condyle is larger anteroposteriorly than the medial.(fig 1:)

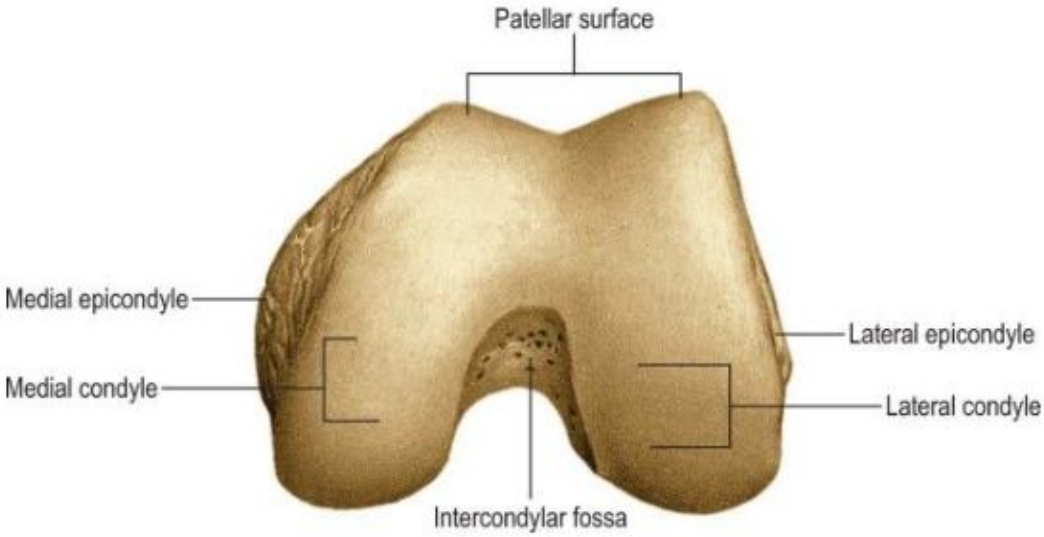


Fig :1 Distal femur articular surface

Tibia

The proximal tibia consists of medial and lateral condyles, an intercondylar area and the tibial tuberosity.The articular surface of the lateral tibial plateau is flat or slightly convex in relation to the medial tibial plateau that is concave.

Both the medial and lateral articular surfaces are covered by hyaline cartilage and are partially covered by the fibrocartilaginous menisci, both of which are attached to their respective plateaus by the meniscotibial ligaments (coronary ligaments).

The intercondylar eminence and medial and lateral tibial spines, which are nonarticular, separate the two plateaus.

Patella

The patella is the largest sesamoid bone and is embedded in the tendon of quadriceps femoris anterior to the distal femur (femoral condyles). It is flat, distally tapered, proximally curved, and has anterior and posterior surfaces, three borders and an apex which is the distal end of the bone. With the knee in extension, the apex is just proximal to the line of the knee joint.

Fig 2:Left patella: anterior aspect.

1. Area of rectus femoris attachment. **2**. Medial border: attachment of medial retinaculum (expansion). **3**. Apex. **4**. Area of attachment of vastus intermedius. **5**. area of attachment of quadriceps tendon. **6**. Lateral border: attachment of lateral retinaculum (expansion).

Fig 3: Left patella: articular surface

. **1**. Upper lateral facet: in contact with femur during flexion. **2**. Lower lateral facet: in contact with femur in extension. **3**. Area overlain by edge of circumferential fat pad. **4**. Upper medial facet: in contact with femur in flexion. **5**. Medial vertical facet: in contact with femur in extreme flexion. **6**. Lower medial facet: in contact with femur in extension. **7**. Ridge. **8**. Area covered by infrapatellar fat pad. **9**. Area for attachment of patellar tendon.

Patella is longitudinally ridged, separated from the skin by a prepatellar bursa, and covered by an expansion from the tendon of quadriceps femoris, which blends distally with superficial fibres of the patellar tendon, the continuation of the tendon of quadriceps.(fig 2)

The posterior surface has a proximal smooth, oval articular area, crossed by a smooth vertical ridge, which fits the intercondylar groove on the femoral patellar surface and divides the patellar articular area into medial and lateral facets; the lateral is usually larger.(fig 3)

In the medial and lateral borders the expansions of the tendons of vastus medialis and lateralis (medial and lateral patellar retinacula respectively) are attached to them. The lateral retinaculum receives contributions from the iliotibial tract. The apex represent the attachment of the patellar tendon.

Muscles around knee joint

The extensor mechanism is formed by quadriceps femoris and its tendon, patella and its tendon. Quadriceps femoris is formed by rectus femoris and the three vasti muscles.(fig 4)

Rectus femoris has two origins from anterior inferior iliac spine and the acetabulum. The two heads join to form a flat tendon and attaches to base of patella. This forms the superficial central part of quadriceps tendon. Just beneath is the vastus intermedius which has its origin in the anterior and lateral surface of proximal femur and attaches with rectus femoris as a tendon distally.

The vastus medialis and lateralis arises from proximal femur and traverses the medial and lateral side of the proximal femur and attaches to quadriceps tendon, and contributing medial and lateral expasions around patella. Vastus lateralis blends with iliotibial band and attaches to proximal tibia. The flexion movement of knee joint is executed by biceps femoris, semitendinosus, semimembranosus, gracilis, and also by gastrocnemius.(fig 5).

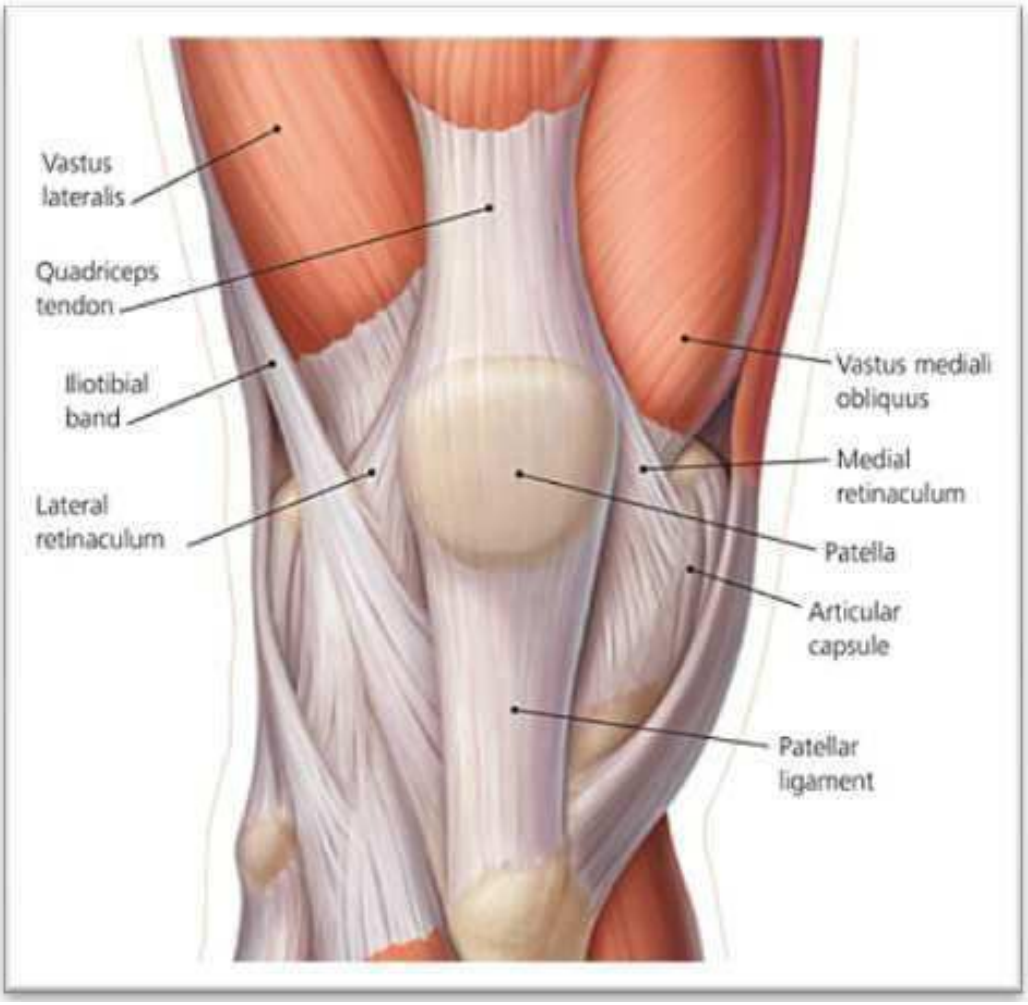


Fig 4: Extensor mechanism

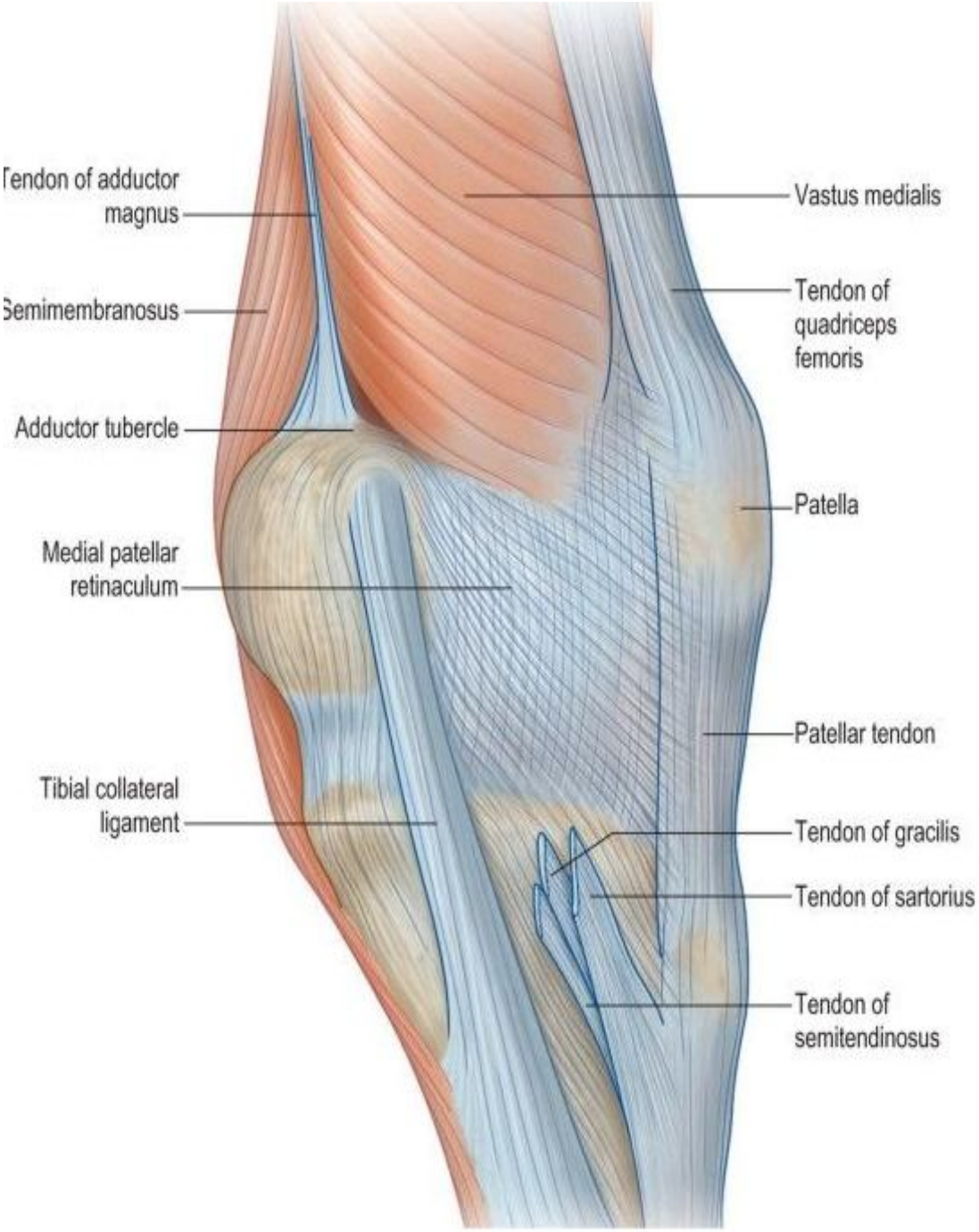


Fig 5: Medial aspect of knee joint

Ligaments of knee joint

Ligaments are mainly intracapsular and extracapsular.

Extracapsular ligaments

The joint capsule is strengthened by five extracapsular ligaments namely patellar ligament, fibular collateral ligament, tibial collateral ligament, oblique popliteal ligament and arcuate popliteal ligament.(fig 5)

The **patellar ligament**, the distal part of the quadriceps tendon is a strong fibrous tendon passing from the apex and adjoining margins of the patella to the tibial tuberosity.

The **fibular collateral ligament** extends inferiorly from the lateral epicondyle of the femur to the lateral surface of the fibular head.

The **tibial collateral ligament** (medial collateral ligament) extends from the medial epicondyle of the femur to the medial condyle and the superior part of the medial surface of the tibia. At its midpoint, the deep fibers of the TCL are firmly attached to the medial meniscus. The medial collateral ligament, weaker than the lateral collateral ligament, is more often damaged.

Intra capsular ligaments

The intra-articular ligaments within the knee joint consist of the cruciate ligaments and menisci.(fig 6)

Anterior cruciate ligament

The anterior cruciate ligament arises from the anterior intercondylar area of the tibia, just posterior to the attachment of the medial meniscus. It extends superiorly, posteriorly, and laterally to attach to the posterior part of the medial side of the lateral condyle of the femur. It prevents posterior displacement of the femur on the tibia and hyperextension of the knee joint.

Posterior cruciate ligament

The posterior cruciate ligament arises from the posterior intercondylar area of the tibia. The PCL passes superiorly and anteriorly on the medial side of the ACL to attach to the anterior part of the lateral surface of the medial condyle of the femur. It prevents posterior displacement of the tibia on the femur and helps prevent hyperflexion of the knee joint and main stabiliser in walking downhill movements.

Menisci

The menisci of the knee joint are crescentic plates of fibrocartilage on the articular surface of the tibia that deepen the surface and play a role in shock absorption.

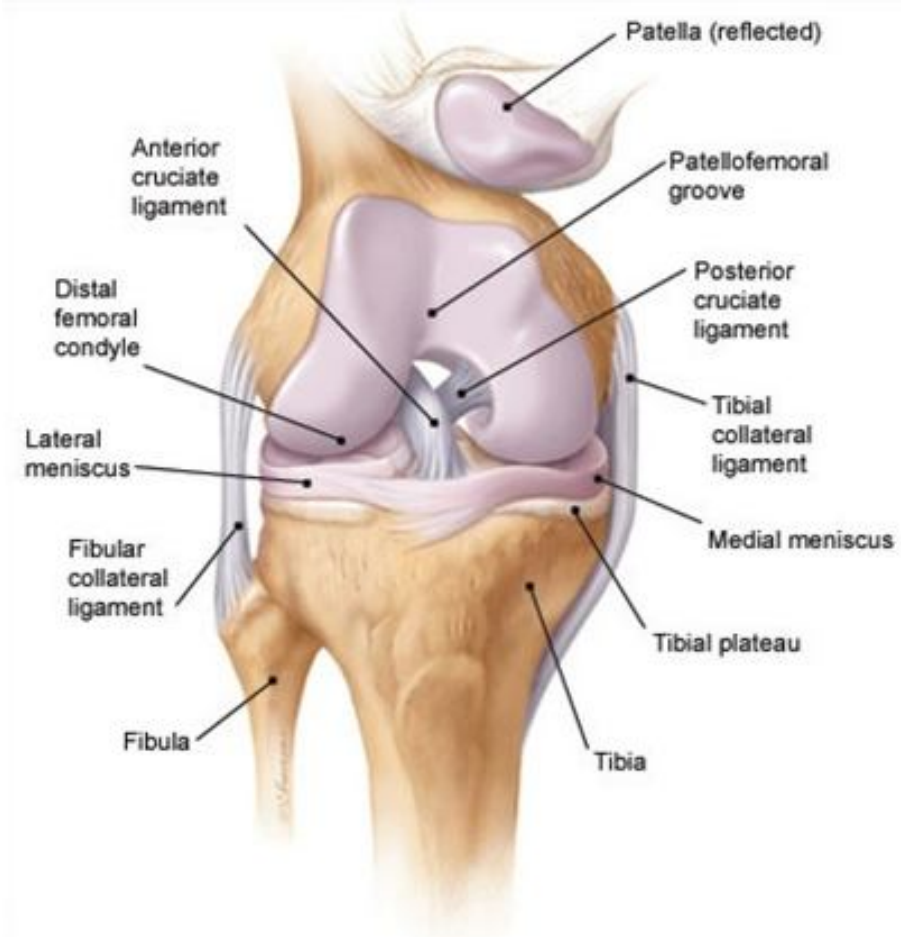


Fig 6: Intracapsular ligaments of knee joint

Blood supply of knee joint

There is an intricate arterial anastomosis around the patella and femoral and tibial condyles. The vessels involved are the superior, middle and inferior genicular branches of the popliteal artery, descending genicular branches of the femoral artery, the descending branch of the lateral circumflex femoral artery, the circumflex fibular artery and the anterior and posterior tibial recurrent arteries.(fig 7)

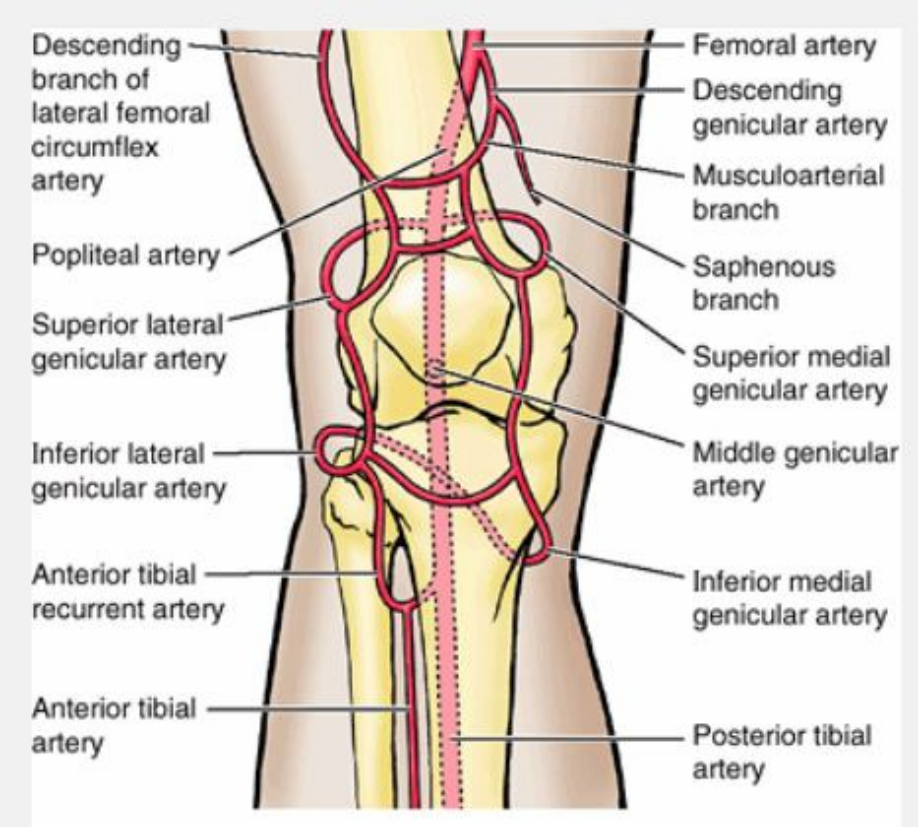


Fig 7:Blood supply of knee joint

Knee joint kinematics

The articulations of knee joint are tibiofemoral and patellofemoral. To move, the human body requires large flexion of knee. For walking ,70° of flexion is required and up to 120° may be required when rising from a chair.

Flexion of the tibiofemoral joint involves translation (femoral roll back) as well as flexion. Tibiofemoral forces are around three times body weight for walking, but can be upto four times body weight when walking downstairs. The patellofemoral forces are lower than tibiofemoral force , with walking around 0.6 times body weight and walking downstairs three times body weight.

Patellofemoral joint plays an active role in quadriceps functioning especially in loaded flexed knee. Patellectomy leads to shortened lever arm and during flexion patellar tendon will sink into intercondylar notch,severely compromising the strength of quadriceps mechanism. In stiff knee patellofemoral adhesions and capsular fibrosis are often seen in all patients and there will be associated quadriceps atrophy and thus loss of quadriceps power.[(25)]

Unlocking of knee joint is initiated by popliteus muscle leading loosening of ligaments and finally hamstring causes flexion of knee joint.

The mechanism of knee stiffness following a traumatic event is due to

1) fibrosis of vastus intermedius in the lower third of thigh and adhesions to femur and to rectus femoris.

2) actual shortening of rectus femoris

3) adhesions of patella to femoral condyles

4) paracondylar aponeurotic expansions of vasti getting attached to sides of femoral condyles.

5) inside of knee joint adhesions between tibio femoral articular surfaces.

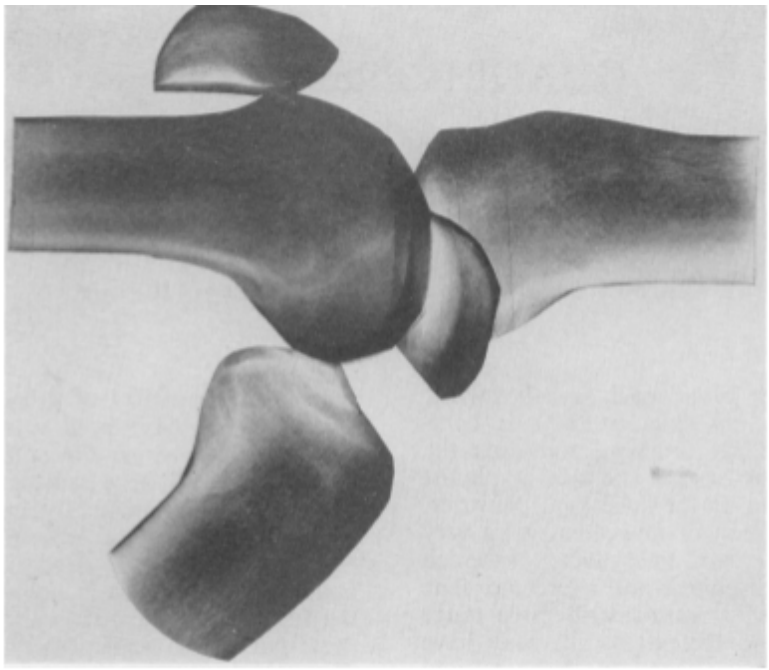


Figure 8: Superimposed X ray showing excursion of patella between extension and flexion.

Adhesions or contractures in the extraarticular part of knee joint limits the distal excursion of patella and quadriceps during flexion.(fig 8)

Review of literature

"George E Bennett" in 1922 described a lengthening procedure of knee in which the rectus femoris is released from surrounding muscular adhesions and then tendon is cut transversely following which knee is mobilised and finally distal end of rectus femoris is sutured to the vatus medialis and vastus lateralis on either side.[1] (fig 9,10)

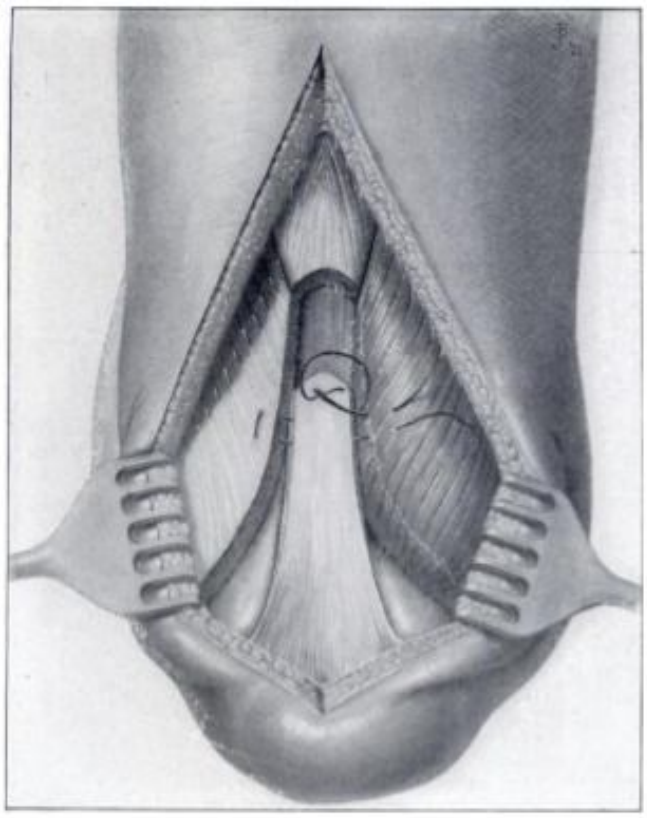


Figure 9: Transverse release of rectus femoris

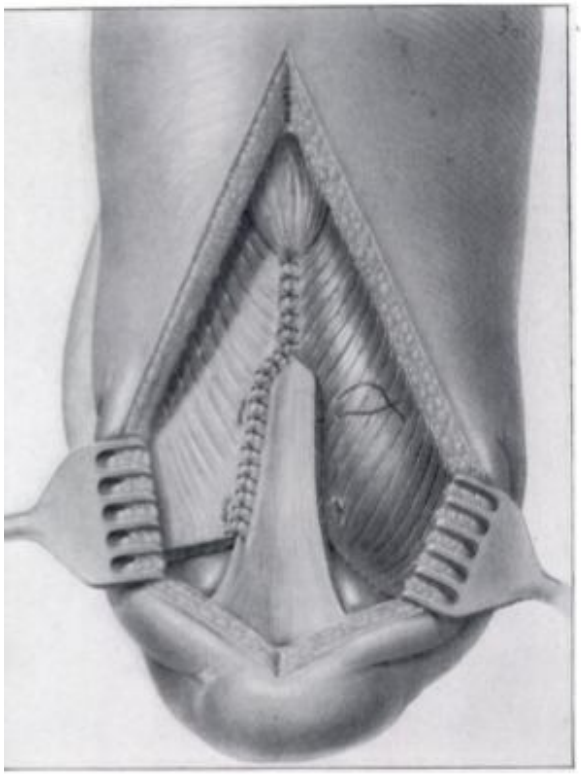


Figure 10 : Suturing of rectus with vastus muscles

Thomson T C in 1944 modified Bennett's quadriceps lengthening and described the following technique.

1) The rectus is not lengthened instead isolated from the vasti muscles.

2) The vastus intermedius is scarred in all his cases and he excised Vastus intermedius muscle.

3) Immobilisation following quadricepsplasty is not necessary and he started both active and passive mobilisation immediately.[(2)]

Nicolle in 1963 also reported 17 percent failure rate due to tight rectus that could not adequately and safely released by the Thompson technique.He described that the stiffness is due to adhesions between vastus intermedius and femur or between patella and the femoral condyles,or they may be a contracture of the medial and lateral retinacula or the rectus femoris.[3]

Nicoll[3] described that "inexperienced operator may well get the impression half way through that he is about to ruin the patients knee for life . If he steels himself against the temptation to pull out in time ,the knee looks such a shambles at the end of the operation that he may well panic and starts sewing things up again.This is a fatal mistake,for he is merely recreating the conditions that he has been at such pains to disturb". Nothing but the skin should be sutured ,but this must be done very carefully indeed to ensure primary healing and allow early movements.

Judet et al in 1959 devised a new technique based on Payr's method ofquadricepsplasty and described that the vastus medialis should not be disturbed as it has origin in the linea aspera and it has an oblique course to patella therefore playing only accessory role in contractures . Judet et al described distal to proximal release in which knee arthrolysis

and vastus release and rectus femoris release is done which is described later in techniques.[4]

Hesketh in 1963 reported 10 cases of Thompson quadricepsplasty with slight modifications. He insisted not to use tourniquet because many large vessels that are cut particularly in the parapatellar area are to be seen and secured.[5]

H Daoud et al in 1982 decribed the judet technique of quadricepsplasty along with slight modifications and compared it to Thomson quadricepsplasty.He reported that the Thompson quadricepsplasty resulted in weak extension and marked extension lags which were often permanent.He concluded that the judet technique is superior to that of Thompson.[6]

Kettlekamp et al has shown that 110°degree of flexion is necessary in both knees to get up from sitting position and 70° knee flexion is necessary for a normal gait. Therefore the aim of surgical treatment is to achieve flexion of 110° to 120 degrees.[7]

J.Bellemans et al in 1996 evaluated judet's quadricepsplasty in sixteen cases retrospectively and reported the improvement in average flexion of69° with 11 patients achieving a final flexion of 90 degrees or more.[8]

Sengupta in 1985 reported 33 children with 52 extension contracture of knee after repeated intramuscular injections or infusions who were not able to squat or sit in floor and also presented with unstable gait .

Sengupta recommended proximal release to eliminate extensor lag and hemarthrosis of the knee.[9]

In 1985 *Santo S, Kokubun S* classified quadriceps contractures into three classes (table 1). The exact mechanism is unclear but suggested causes include compression of the muscle bundles and capillaries by the volume of medication injected and the toxicity of the drug. These leads to intermuscular fibrosis and contractures of injected muscles and thus leading to stiff knee.[10]

	Knee flexion	When knee is forced to flex in prone position
Rectus femoris type	Restricted with hip extension	Hip is forced to flex
Vastus type	Restricted with hip flexion	Hip remains same
Mixed	Slightly restricted with hip extension	Hip is forced to flex

Table 1 Classificaton of knee contractures

Hnevkovsky in 1961 described a disorder in 12 patients that he called "progressive fibrosis of the vastus intermedius muscle in children."[(11)]

Fairbank and Barrett in 1961 reported identical twins with quadriceps contractures and they believed these contractures to be of congenital origin.[(12)]

Nozawa et al in 2004 reported a patient with congenital quadriceps contracture that was also found in her brother.[(13)]

Jackson and Hutton in 1985 reported patella alta, fragmentation of the inferior pole of the patella, and hypoplastic patellae.[(14)]

Sasaki et al in 1985 followed 65 patients and reported that the best results were obtained using a longitudinal skin incision over the rectus muscle through which the fibrotic muscle was released with a transverse incision. Several transverse incisions through the fibrotic iliotibial band and quadriceps fascia also were often necessary.[15]

Lloyd-Roberts and Thomas in 1964 reported quadriceps contractures in infants resulting from multiple injections or infusions into the thigh soon after birth.[16]

S.B.Hahn et al in 2000 described a modified Thomson quadricepsplasty in which incision is done laterally or anterolaterally and final 'Z' lengthening of rectus femoris tendon.[17]

H.S.Hosalker et al in 2003 done a V-Y lengthening quadricepsplasty for rectus femoris with adhesion release for five children after femoral lengthening in congenital short femur and reported excellent results in three patients, good in one and fair in one according to judet's criteria.[18]

Z S Kundu et al in 2007 evaluated the results of thompson quadricepsplasty done in twenty two cases with excellent functional outcome.[19]

Saurabh khakharia et al in 2009 described a technique of " limited quadricepsplasty for extension contractures during femoral lengthening" in which the vastus intermedius alone is cut transversely and reported a mean flexion of 125° with good functional outcome.[20]

Yu chi huang et al in 2006 reported extension contractures in twenty four cases of patellar fractures for which they were proceeded with modified Thomson quadricepsplasty with good postop results.[21]

M.A.Fiogbe et al in 2013 has devised a method of distal quadricepsplasty in which rectus femoris tendon cut distally and vastus intermedius cut proximal to rectus transection and sutured in knee flexion .[22]

Bari et al in 2013 reported 32 cases of Judet's quadricepsplasty with mean active flexion of 70°.[23]

Wang, Zhao and He in 2007 described an extraarticular "mini-invasive" quadricepsplasty followed by intraarticular arthroscopic lysis of adhesion. Their procedure is done in five stages; the range of flexion is measured after each stage of release, and the procedure is terminated when the desired degree of flexion (ideally 120 degrees) is obtained.[24]

Techniques of Quadricepsplasty

1) Distal quadricepsplasty

a) V-Y quadricepsplasty

b) Thompson's quadricepsplasty

c) Bennet's quadricepsplasty

2) Proximal release

a) Judet's quadricepsplasty

b) Sengupta's proximal release

c) Lenart and kullmann's proximal release of isolated rectus femoris contracture

3) Other techniques

a) Limited quadricepsplasty

b) Mini quadricepsplasty

c) Distal quadricepsplasty using a modified thompson-payr procedure

V-Y quadricepsplasty

Through anterolateral incision ,skin and subcutaneous tissue incised , rectus femoris exposed and it is isolated from the vastus medialis and lateralis in the distal third of muscle. An inverted 'V' shaped incision is made at the musculotendinous junction and full flexion is attempted and sutured in 'Y' shaped manner. Drain kept and wound closed in layers . Postoperatively patient is given above knee slab in 90 degrees for 1 week and active quadriceps exercise started. The main disadvantage is the occurrence of extension lag.

Thompson's quadricepsplasty

- An anterior longitudinal incision is made from proximal third of thigh to the distal pole of patella.
- Skin and subcutaneous tissue incised and rectus femoris exposed. (Fig 11)
- Rectus femoris muscle is separated from the vastus medialis and lateralis.(fig:12)

- Then the anterior part of the capsule of the knee joint including the lateral and medial expansion is divided far enough to overcome contractures.
- Usually vastus intermedius is scarred completely and it is completely excised. (fig: 13)
- Now the knee is flexed upto 110° to release remaining adhesions.
- If the vastus medialis and lateralis are badly scarred, subcutaneous tissue and fat are interposed between vasti and the rectus femoris. (fig14)
- Now the knee is forcibly bent for mobilisation. (fig 15)
- If flexion is still prevented ,then some lengthening procedures for rectus femoris should be considered.

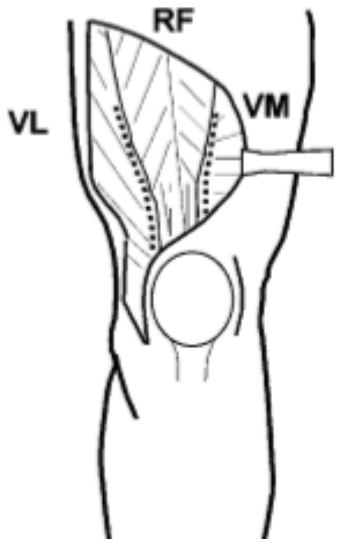


Figure: 11:Exposure of rectus femoris

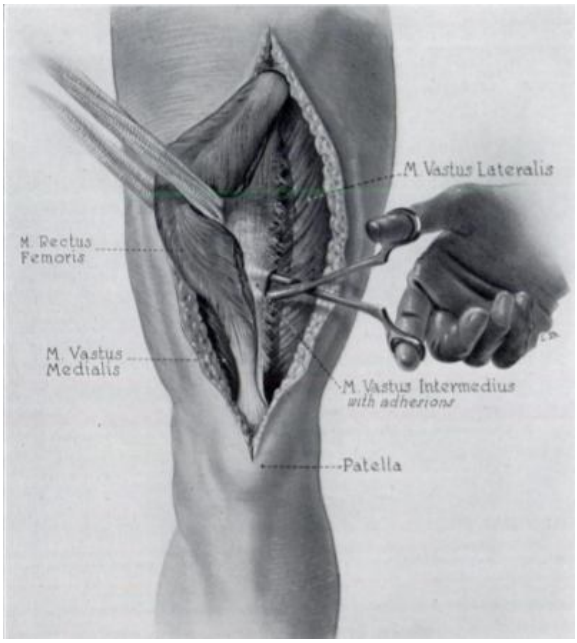


Figure :12 Release of rectus femoris from vastus intermedius

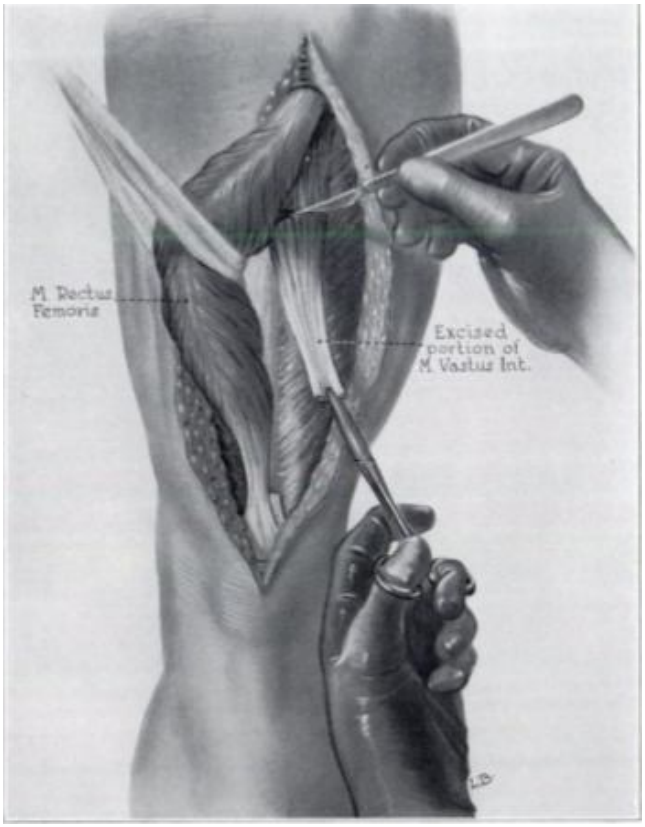


Figure 13: Excision of vastus intermedius

\

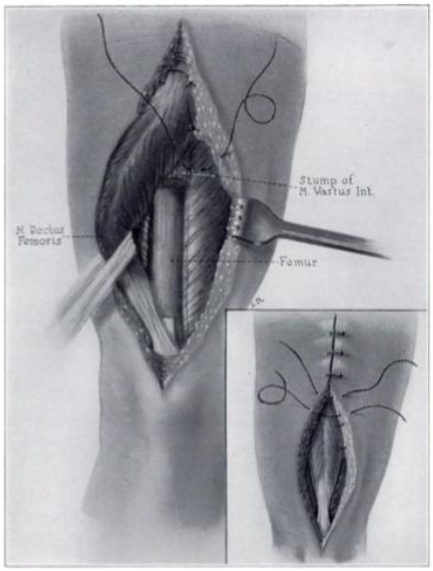


Figure 14 : Vastus intermedius sutured to vastus lateralis and soft tissue drawn down between vastus lateralis and rectus femoris

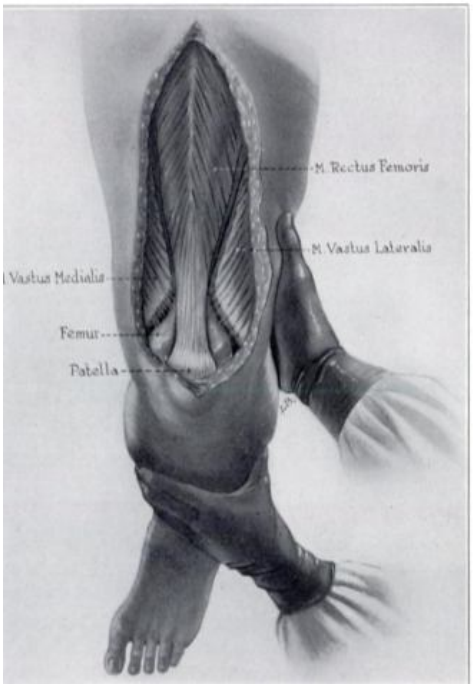


Figure 15: Vastus medialis and lateralis released on either side and knee is forcibly bent

Bennet's quadricepsplasty:

- After anaesthesia patient was subjected to knee flexion manipulation for several minutes in an effort to break up joint adhesions . Only few degrees of knee flexion was obtained in this manoeuvre .
- Thigh painted and draped ,anterior midline incision was made over the quadriceps tendon ,rectus femoris was found to be contracted when the knee is flexed .(fig 16)
- Rectus femoris was divided and fibres of vastus medislis and lateralis dissected loose from the rectus femoris .(fig 17)
- The knee was flexed over 90 degrees and the motion was quiet free.
- The vastus medius and lateralis tendons were sutured to the distal end of the cut rectus femoris tendon in 90 degrees of knee flexion .
- Drain kept , only subcutaneous tissue and skin closed in layers dressing done .
- Post operatively patient was given above knee slab in 90 degrees of knee flexion .After 2 weeks cast removed mobilisation done .

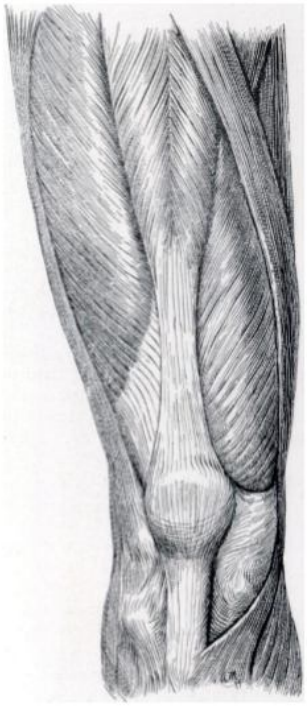


Figure 16: Quadriceps muscle

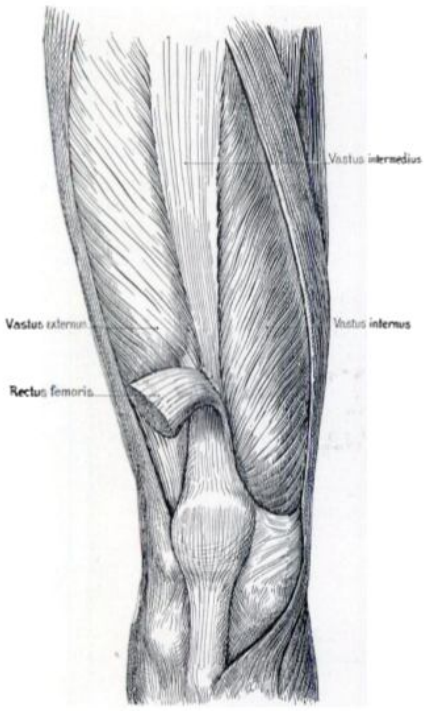


Figure 17: Sectioning of rectus femoris

Sengupta’s proximal release

- Curved incision is made along the base of the greater trochanter and extended vertically downwards along the distal end of femur.
- Ilio tibial band is sectioned transversely .
- Then the upper attachment of vastus lateralis below the trochanter is exposed and detached.
- As vastus lateralis is released ,vastus intermedius is exposed and periosteal elevator is used to release vastus intermedius from its femoral attachment.
- If rectus component is also contracted,then expose it proximally and detached from its origin after retracting femoral nerve. (fig 18)

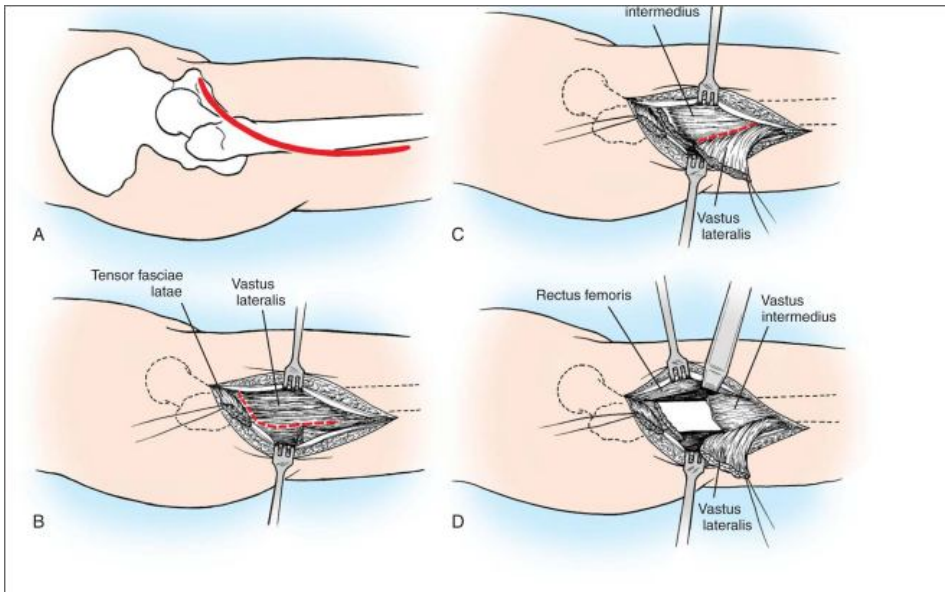


Figure 18 : Sengupta’s proximal release

Judet's quadricepsplasty

- Through antero medial incision near the medial parapatellar retinaculum and capsule incised and intraarticular adhesions released.(fig 21)
- The suprapatellar pouch is mobilized or excised via the intra-articular route.
- The knee is flexed and few degrees of flexion is gradually gained. Further flexion is prevented by the fibrosed quadriceps.
- Care must be taken not to incise the vastus medialis obliqus insertion into the patella.
- A long postero-lateral incision is made just lateral to the patella to 2.5cms below the greater trochanter.(fig 19)
- Lateral parapatellar and capsular adhesions released.(fig 20)
- Vastus lateralis is separated from rectus femoris and also from linea aspera and proximally detached from its origin.(fig 23)
- Vastus intermedius is lifted using periosteal elevator from the anterior and lateral surface of femur .
- If desired flexion is still not obtained then rectus femoris is detached from its attachment from anterior inferior iliac spine and acetabulum.(fig 22)
- Skin and subcutaneous tissue closed in layers.

- Postoperatively mobilisation exercises begin on the next day with continuous passive motion device and continued daily for next two weeks.

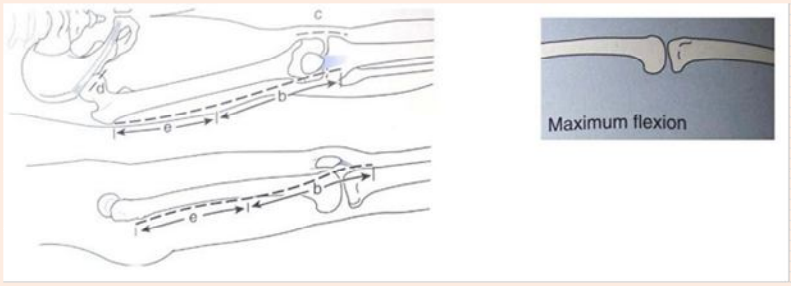


Figure 19: Posterolateral incision

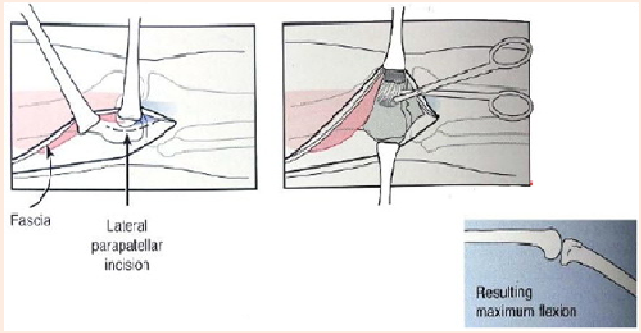


Figure 20: Lateral release of adhesion

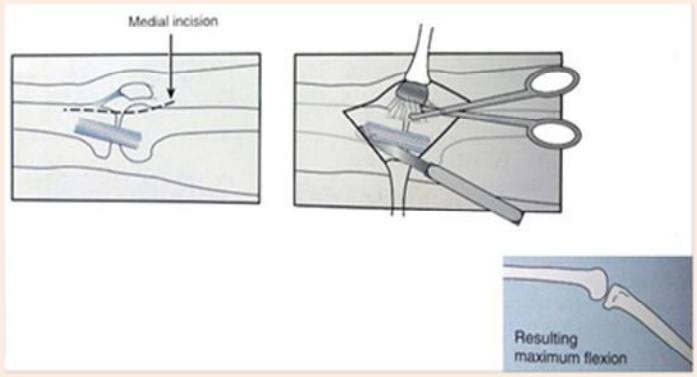


Figure 21: Medial retinaculum release

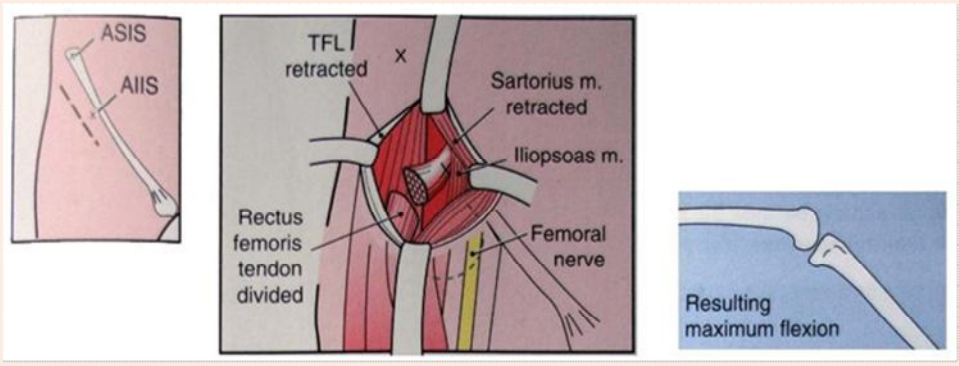


Figure 22 : Rectus femoris release

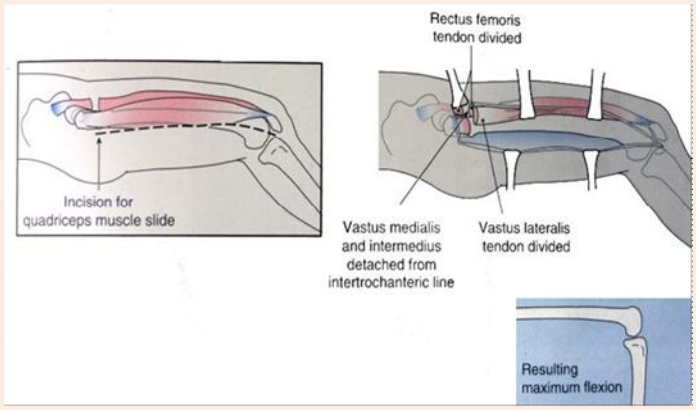


Figure 23: Vastus lateralis and intermedius release

Lenart and Kullmann's proximal release

- This technique is described for isolated contractures of rectus femoris.
- The incision begins below the anterior superior iliac spine and extended distally.
- The origin of rectus femoris is exposed both on anterior inferior iliac spine and acetabulum,when knee is flexed the muscle stretches like a cord .
- Both the origins are detached and knee is flexed with hip extended.

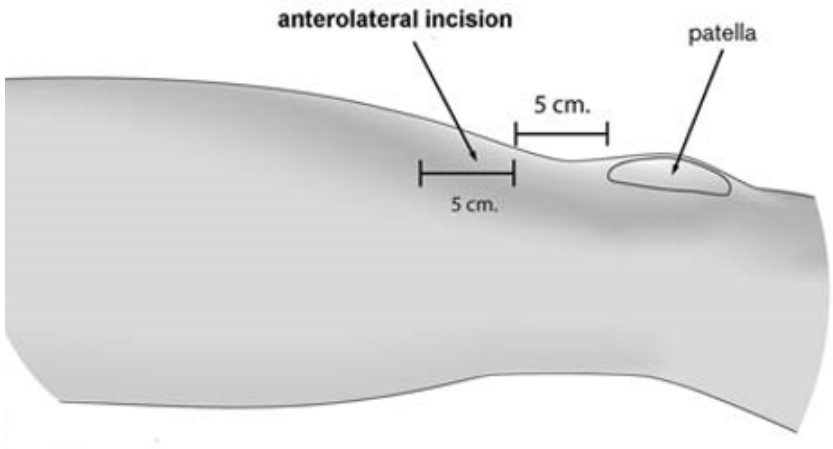
Limited quadricepsplasty

This technique is employed in stiff knee following lengthening of femur with ilizarov method.

- A 5-cm anterolateral skin incision was made beginning from the superolateral aspect of the patella and extended 5 cm proximally (Fig 24 A). We incised the fascia in line with the fibers of the iliotibial band.
- A transverse fasciotomy was performed to release the iliotibial band and the anterior fascia of the thigh. The vastus lateralis then

was exposed and split longitudinally. This exposed the vastus intermedius muscle and overlying fascia.

- The rectus femoris muscle and fascia were retracted anteriorly . The vastus lateralis was retracted posteriorly. This exposed the entire vastus intermedius.
- The anterior fascia then was released with a transverse cut across its fibers. We took care not to incise any of the muscle tissue. The tight bands of the vastus intermedius were most apparent with the knee in maximum flexion. (fig 24B)
- After releasing these fascial bands, we performed gentle manipulation to obtain maximum knee flexion.(fig 24 C)
- The hip was flexed during the manipulation to avoid excessive stretching of the femoral nerve.



igure 24 A: Anterolateral incison

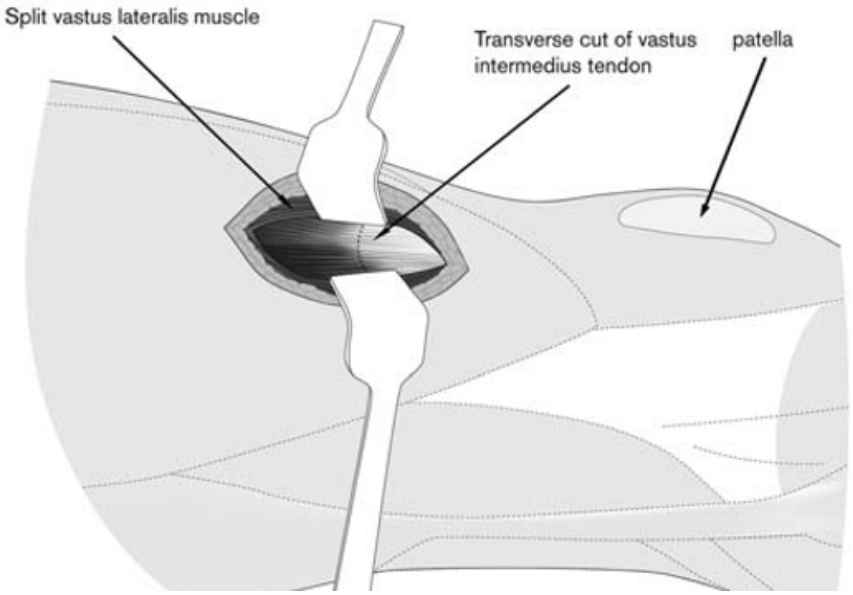


Figure 24 B: Transection of vastus intermedius

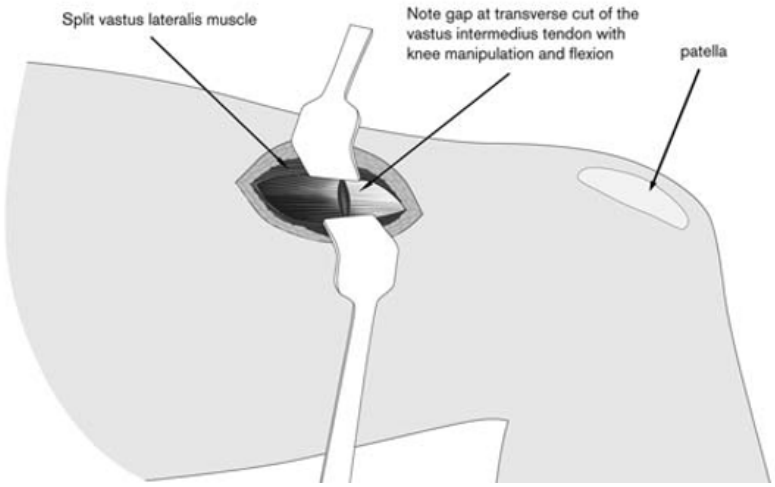


Figure 24 C: Forceful knee flexion

B) Mini quadricepsplasty(Wang,Zao and He) (fig 25)

Stage 1

- With an inside-out technique, make a percutaneous parapatellar lateral arthrotomy by incising the lateral retinaculum from the patella along its lateral border, from the superolateral corner of the patella down to the lateral aspect of its lower pole.

- Free the lateral retinaculum from the lateral femoral condyle, and free the vastus lateralis tendon and the iliotibial band from the distal third of the femur.

Stage 2

- Mobilize the suprapatellar pouch, the patellofemoral compartment, and the anterior interval by dividing the adhesions within these spaces.
- Separate the tendinous tissue of the vastus intermedius from that of the rectus femoris and the anterior surface of the femur.

Stage 3

- With a percutaneous inside-out technique, release the medial patellar retinaculum through the suprapatellar pouch, patellofemoral compartment, and anterior interval that were reestablished in the second stage.
- Take care to avoid detachment of the vastus medialis from its insertion at the superomedial corner of the patella.
- Free the medial retinaculum from the medial femoral condyle, and free the vastus medialis from the distal third of the femur to restore the medial recess.

Stage 4

- Transect the previously mobilized vastus intermedius at a level near its musculotendinous junction.

Stage 5

- The fifth stage consists of lengthening the quadriceps tendon
- Transect the rectus femoris at a more distal level than the vastus intermedius, adjacent to its patellar insertion , and deliver the free tendinous ends of the vastus intermedius and rectus femoris through the wound.

- Gently manipulate the knee in flexion repeatedly until maximal flexion is achieved.
- Then overlap the proximal tendinous end of the vastus intermedius and the distal portion of the rectus femoris tendon and suture them with No. 2 nonabsorbable Ethibond suture with the knee held in 90 degrees of flexion.
- Test the passive range of motion after repair of the quadriceps tendon to ensure that the lengthened tendon is under substantial tension but remains competent at 90 degrees of flexion.
- If the knee can be easily flexed beyond 90 degrees, increase the overlapping of the tendons by more proximal advancement of the vastus intermedius tendon to reduce the risk of creating an extension lag
- Throughout the procedure, manipulate the knee in flexion to release intraarticular adhesions, to assess the arc of knee flexion, and to determine if there are remaining intraarticular adhesions. Once flexion of more than 120 degrees has been achieved, the extraarticular portion of the procedure is terminated, closed suction drains are placed, and the skin is closed.

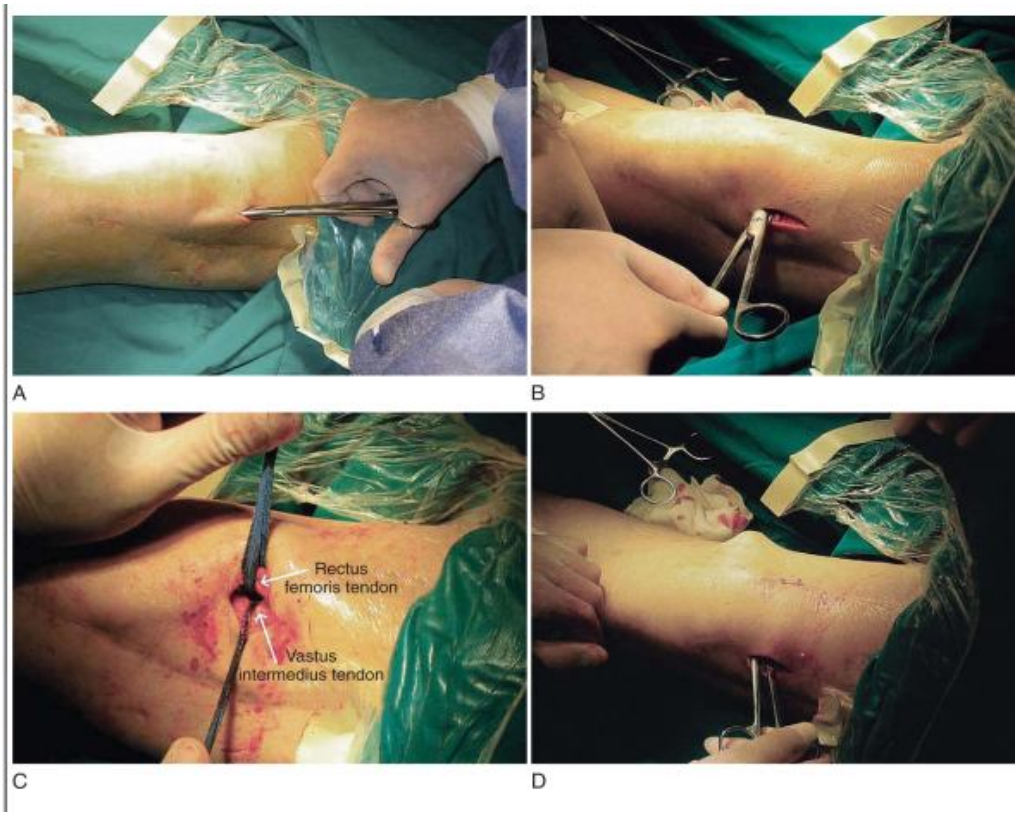


Figure 25: A:Lateral parapatellar retinaculum released, B: Lateral patellofemoral adhesions released, C: Vastus intermedius and rectus femoris separated , D: Medial parapatellar retinaculum released

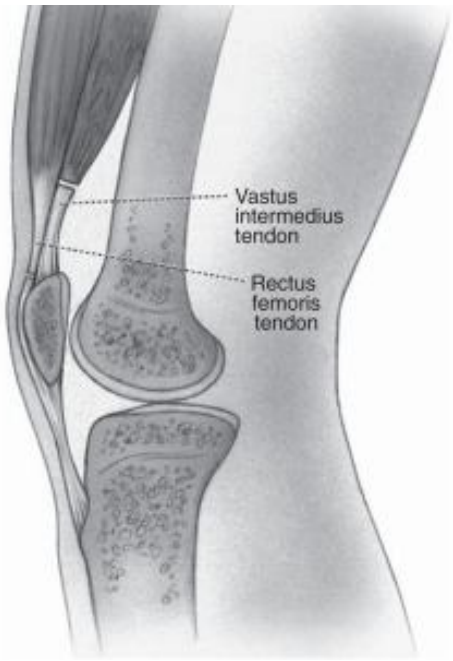


Figure 25 E: Transection of rectus femoris and vastus intermedius tendon

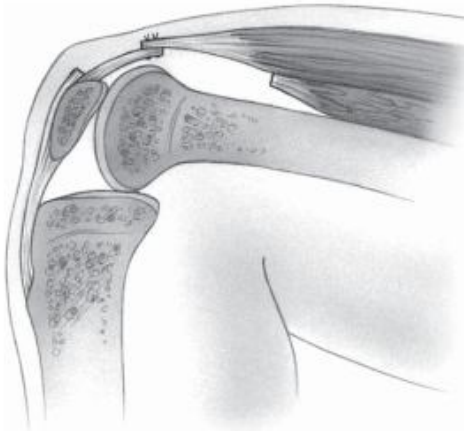


Figure 25 F: Lengthened quadriceps

C) Distal quadricepsplasty using modified Thompson-Payr procedure

This technique is used for retractile fibrosis of quadriceps due to repeated intramuscular injections in anterior thigh.

- A 'H' shaped incision was made in the anterior thigh (fig 26)
- Rectus femoris muscle was mobilised and isolated from the other vastus muscles .
- Rectus femoris tendon was cut distally and flap raised .(fig 27)
- A rectangular shaped musculo tendinous flap was cut from the distal vastus intermedius. Tensor facia latae and medial lateral retinaculae was released.

- Now the knee was mobilised by repeated flexion and extension until maximum flexion was obtained .
- Lengthening reconstruction was done by suturing the tendon of rectus femoris to the vastus intermedius with the knee in 45 degree to 60 degree of flexion and sometimes more .(fig 28)
- Post operative above knee slab was given to the patient in 45° – 60° of flexion for 4 weeks & mobilisation exercises was started after 4 weeks.

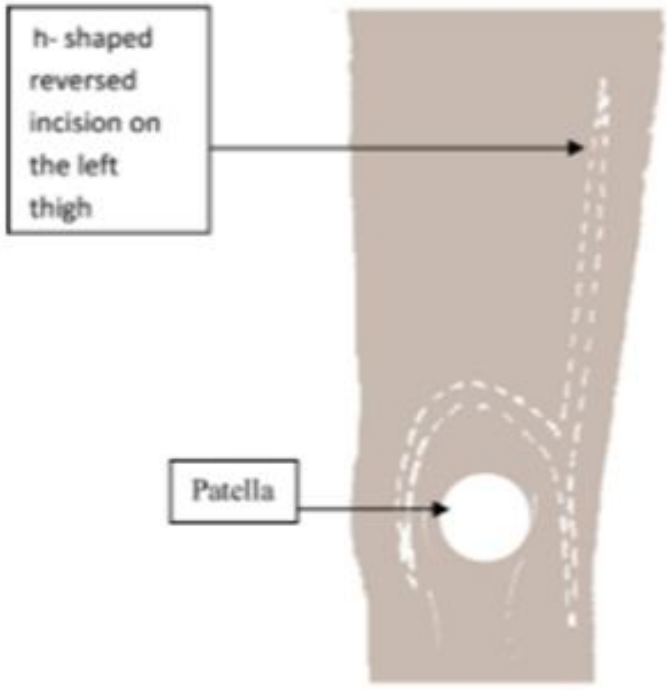


Figure 26 ‘H’ shaped incision

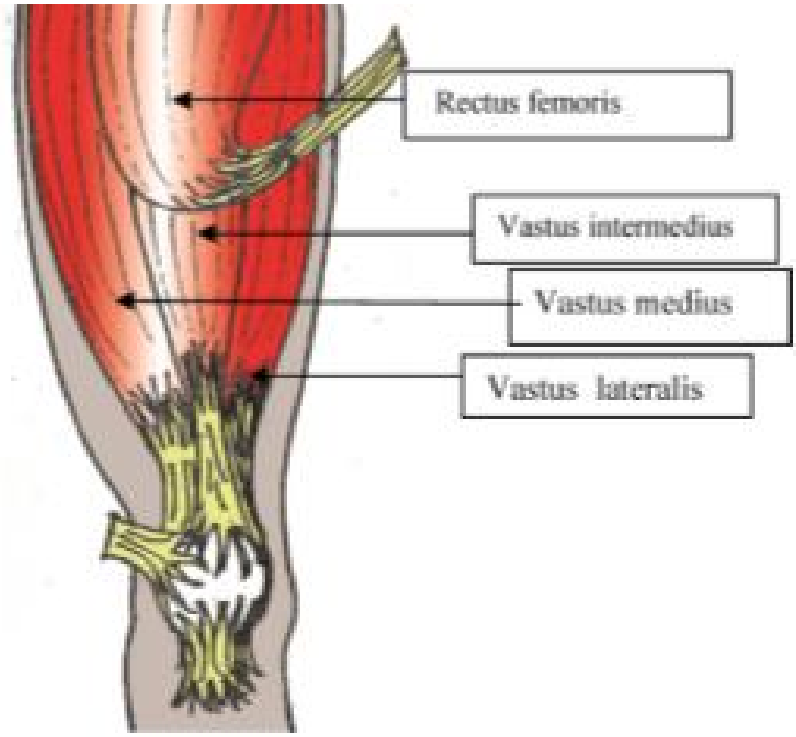


Figure 27: Sectioning of rectus femoris

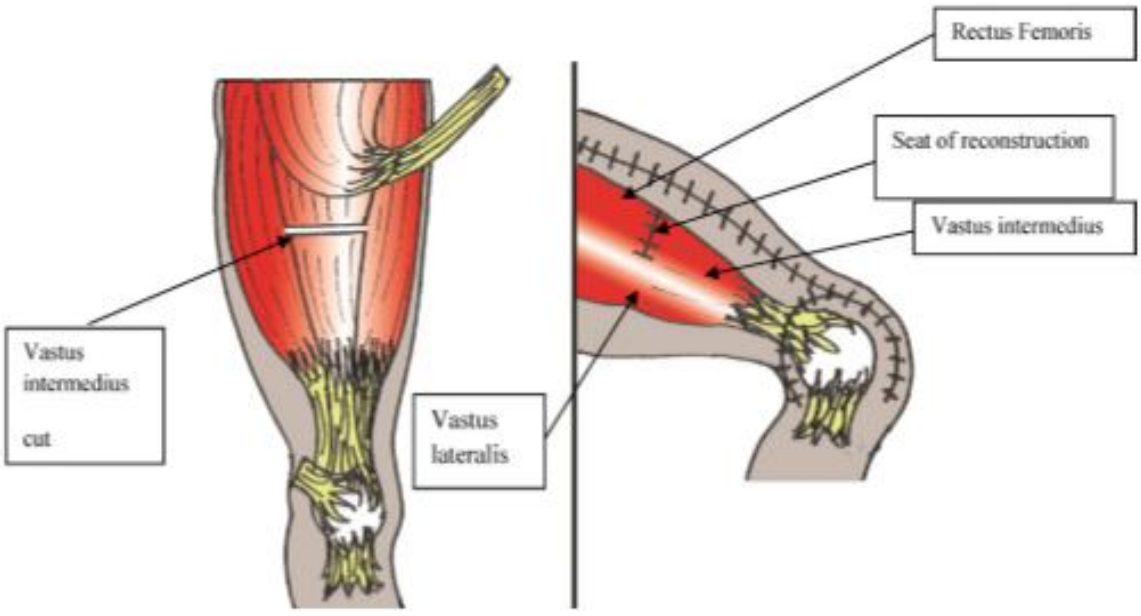


Figure 28: Sectioning of vastus intermedius and suturing with rectus with knee in flexion

Materials and Methods

This study was done to analyse the outcome of quadricepsplasty due to various causes of stiff knee. The patient is assessed for various parameters like range of movement preoperatively and postoperatively,functional improvement following knee mobilisation surgery.

This is a retrospective and prospective study done during the period of January 2014 to September 2016 in Institute of Orthopaedics and Traumatology, Rajiv Gandhi Government General Hospital and Madras Medical College, Chennai. 13 patients of stiff knee were taken up for study after thorough evaluation clinically and radiologically.

Inclusion criteria :

1. Extension contracture of the knee due to extraarticular changes to quadriceps muscle such as fibrosis secondary to fracture and immobilisation, soft-tissue contracture due to old infection.
2. Extension contracture due to intraarticular adhesions and fibrosis due to inadequate rehabilitation and high energy intraarticular fractures.
3. Residual stiffness of knee after failed manipulation under GA.

Exclusion criteria:

1. Active infection of the knee joint or in the surrounding soft tissues.
2. Soft tissue defects in the area of the incision.
3. Noncompliance of patient.
4. Neurologic reasons for flexion contracture.
5. Psychiatric illness.
6. Fixed flexion deformity.

Preoperative evaluation

All patients involved in the study were assessed radiologically and functionally.

Clinical evaluation:

Detailed history and clinical evaluation was done for all patients. All patients were assessed clinically for any comorbid conditions and brought under control preoperatively. Preoperative haemoglobin is brought to 12 gm% and anesthetic fitness was obtained. Knee range of motion is evaluated preoperatively and extension lag if any is noted . Any associated instability of knee joint due to ligamentous injury , skin condition and distal neurovascular deficit if any is noted . Prior history of extensor mechanism defect is noted and planned to address intraoperatively.

Radiological evaluation:

All the patients were taken X ray of the affected knee joint including anteroposterior and lateral view. Fracture site union was assessed and implant exit if can be planned simultaneously.

Surgical technique:

All the patients in our study had undergone one of the three procedures , judet's or Thomson or V-Y quadricepsplasty. If fracture is united implant exit was done along with mobilisation surgery.

Postop protocal:

Judet's technique:

After surgery compressive dressing was done with drain insitu. Epidural catheter is left in situ for 2 days. Epidural analgesia with tramadol was given for 2 days. Active and passive knee mobilisation exercises were started immediately from first postoperative day. Second day drain is removed and wound is evaluated and dressing done. Patient is started on continuous passive motion exercises initially at 90 degree started at first day. Supervised physiotherapy was given for 2 weeks in the ward followed by intense knee flexion and extension exercises including cycling,swimming at home is advised for atleast 6 months .

Thomson's technique:

The extremity is immobilized in a splint 50^0 less than the maximum flexion obtained at operation. This is maintained for 2- 3 days. The extremity is then placed in a continuous passive motion machine and the range of motion exercises is began. Patient should remain in the hospital until he/she obtains a 90^0 passive flexion. Passive and active exercise for quadriceps is continued and are of critical importance to the success of this operation. The knee is kept in full extension in the night and is exercised during the day with active and active assisted exercises. If 90^0 of flexion is not obtained over after 3 months, gentle manipulation under anesthesia is done. Alternatively the limb is immobilized in above knee plaster of paris cast with knee in flexion 20^0 less than what was obtained at surgery for 2-3 weeks. Physiotherapy is started thereafter. The quadriceps power is regained very slowly.

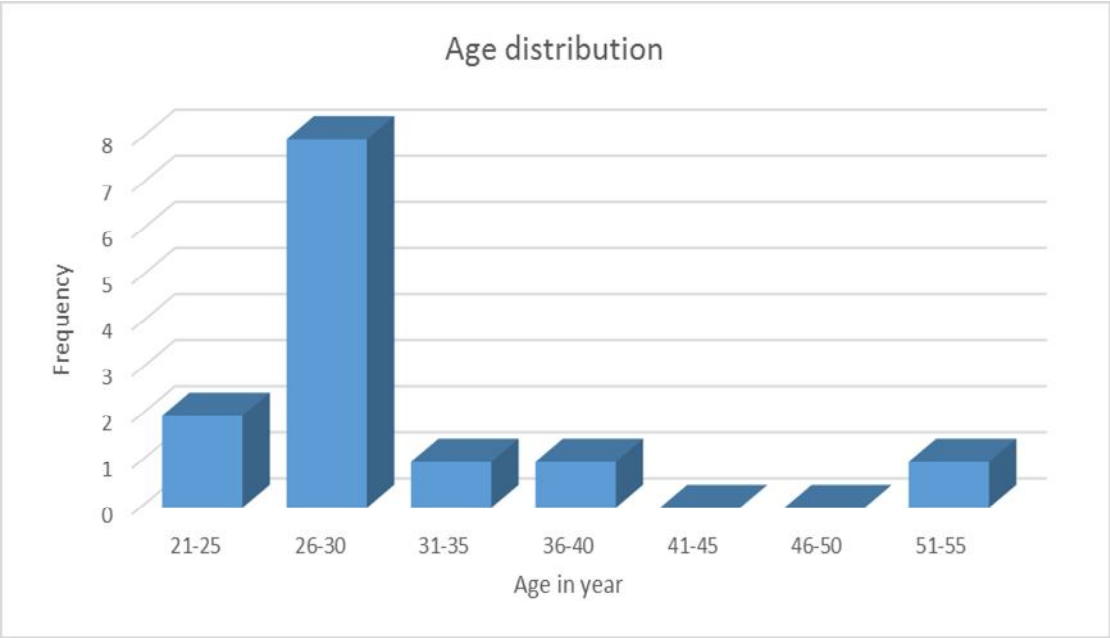
V-Y plasty:

The extremity is immobilised in 90 degree of flexion in above knee slab for 1 week. After 1 week patient is started on active and passive knee stretching exercises. Patient is put on continuous passive motion exercises daily for 2 weeks and discharged . Postoperative extension lag usually persists and slowly recovers over months to years.

Observation and results

1) Age distribution

S.no	Age	Frequency	Percentage
1	21-25	2	15.38
2	26-30	8	61.5
3	31-35	1	7.69
4	36-40	1	7.69
5	41-45	0	0
6	46-50	0	0
7	51-55	1	7.69
		Total	100



In our study most of the patients belong to the age group of 26 – 30 years age group which accounts for 61 % and the mean age is 31 years.

2) Gender distribution

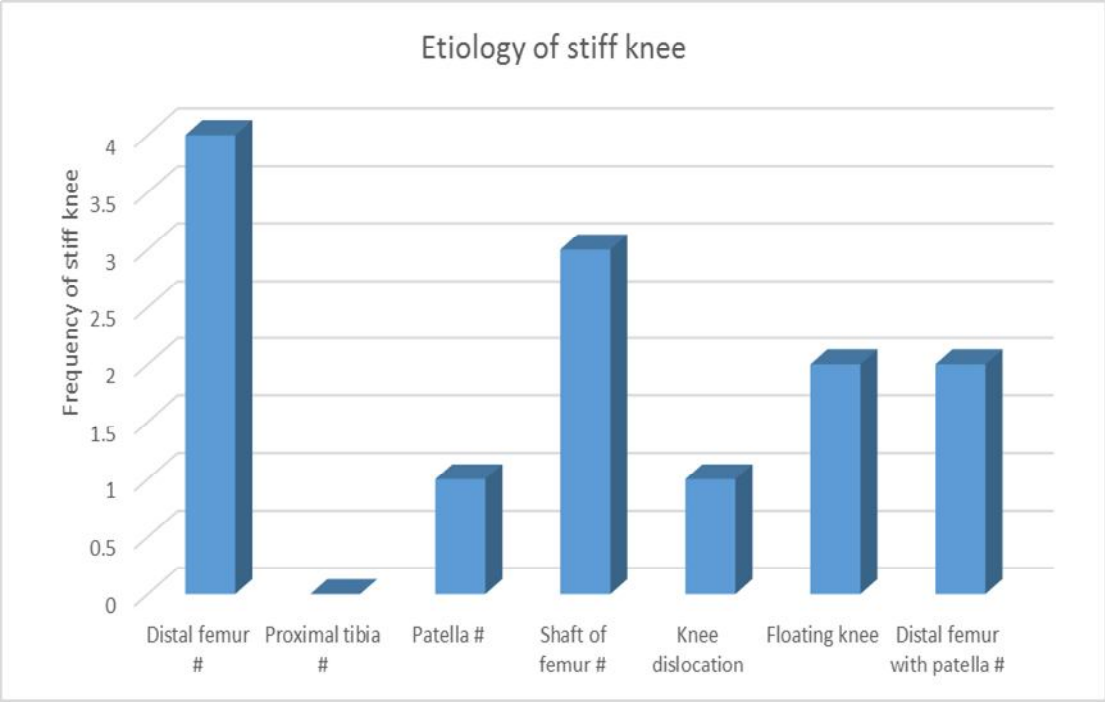
All the patient in our study belong to male gender.

3) Mode of injury

All the patient in our study developed stiff knee due to inadequate mobilisation exercises of knee postoperatively following road traffic accidents.

4) Causes of stiff knee

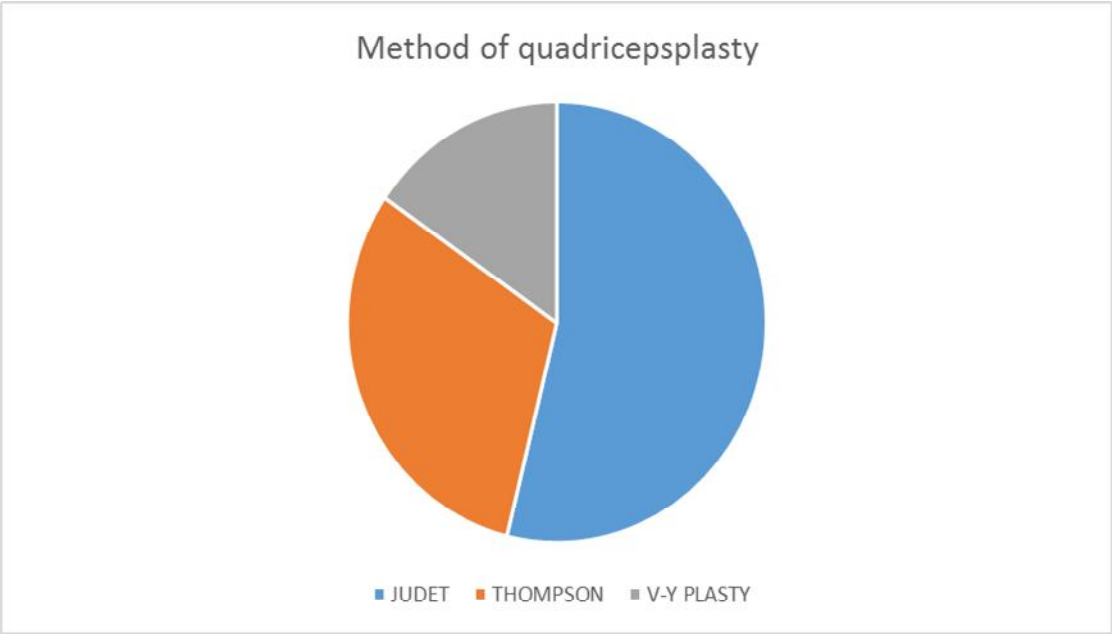
S.no	Etiology	Frequency of stiff knee	Percentage
1	Distal femur #	4	30.7
2	Proximal tibia #	0	0
3	Patella #	1	7.69
4	Shaft of femur #	3	23
5	Knee dislocation	1	7.69
6	Floating knee	2	15.38
7	Distal femur # with patella #	2	15.38



In our series the most common etiology contributing to stiff knee is distal femur fracture accounting for 30 % of cases.

5) Methods of quadricepsplasty

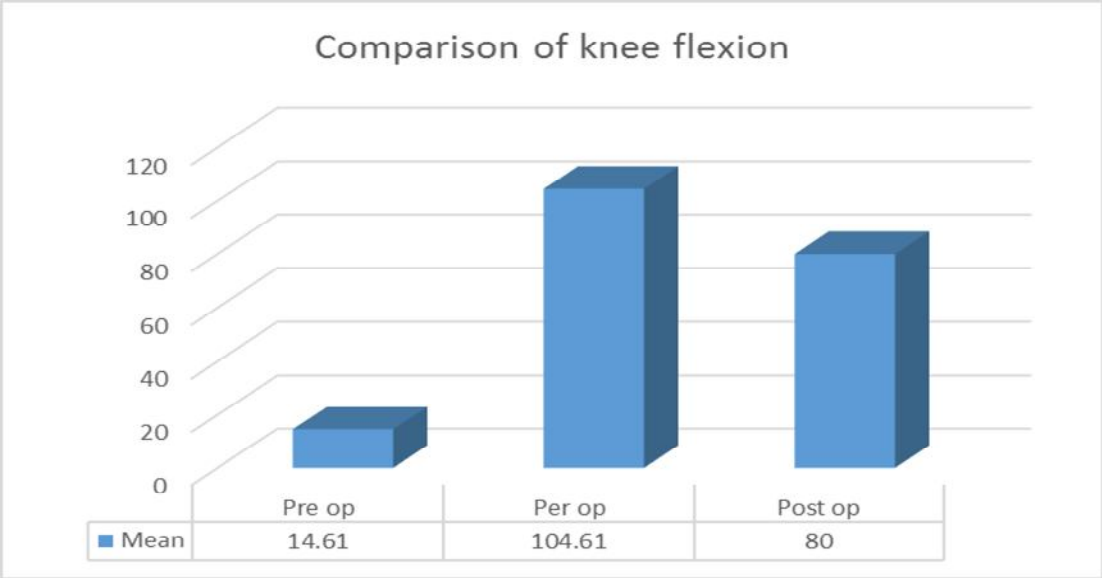
S.no	Method	Frequency	Percentage
1	Judet	7	53.84
2	Thompson	4	30.76
3	V-y plasty	2	15.38



In our study majority of cases undergone Judet's quadricepsplasty accounting for 50%.

6) Comparison of knee flexion :

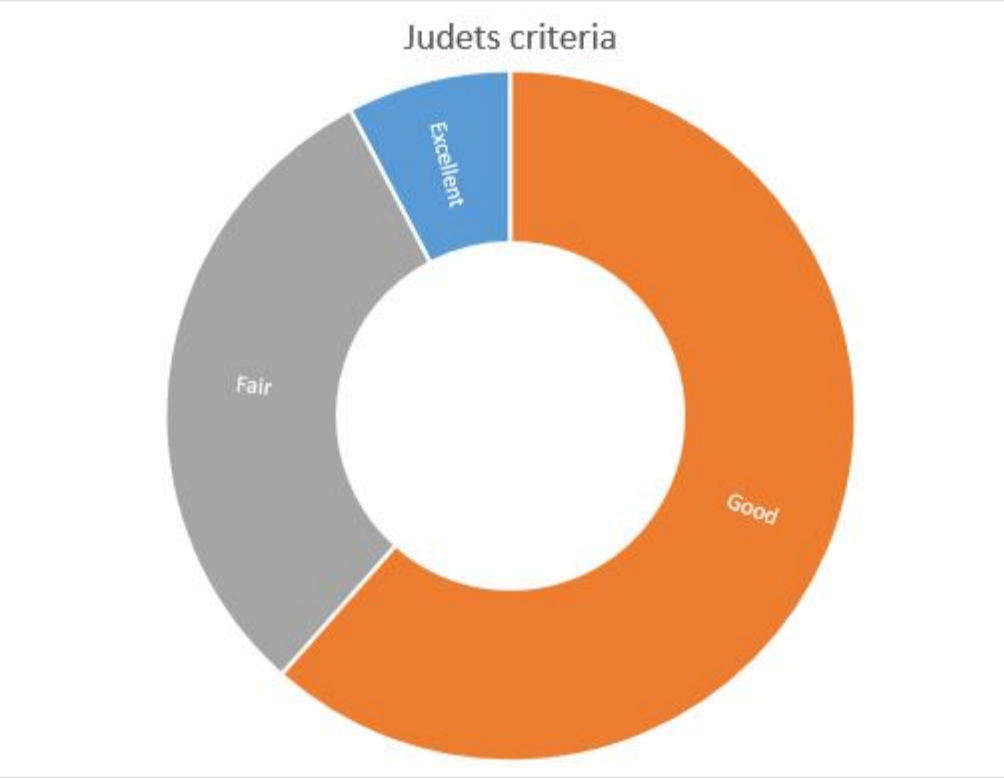
Knee flexion	Mean
Pre op	14.61°
Per op	104.61°
Post op	80°
Gain of flexion	66.15°



The mean preoperative flexion is 14.61° which increased to 80° postoperatively .

7) **Comparison of judet's criteria**

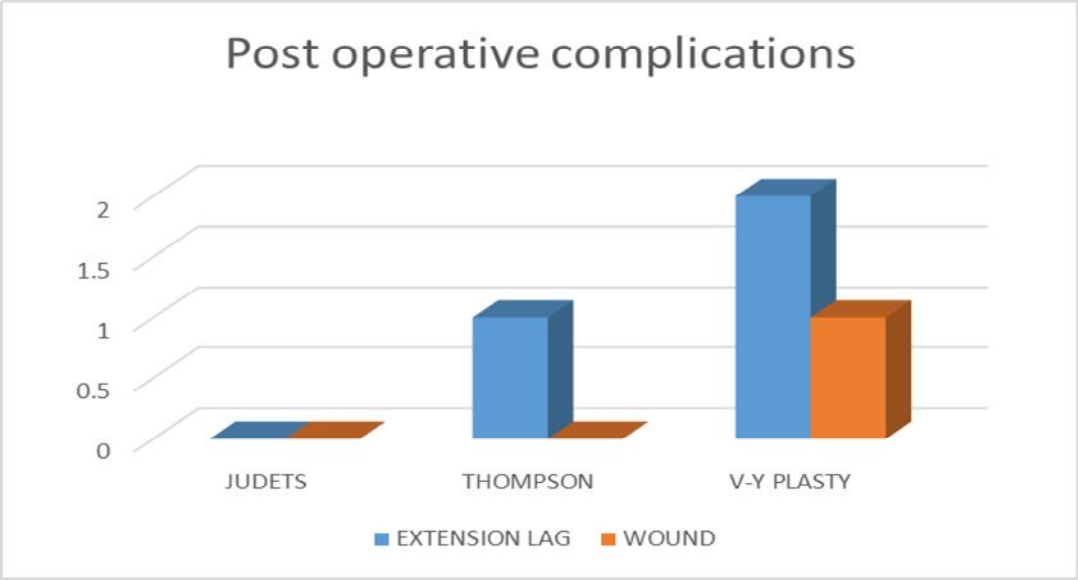
S.no	Judet's criteria	Frequency	Percentage
1	Excellent	1	7.69
2	Good	8	61.53
3	Fair	4	30.76
4	Poor	0	0



In our study the judet's criteria is excellent in only 7.69% and good in 61.53% ,fair in 30.76% and no poor score is obtained.

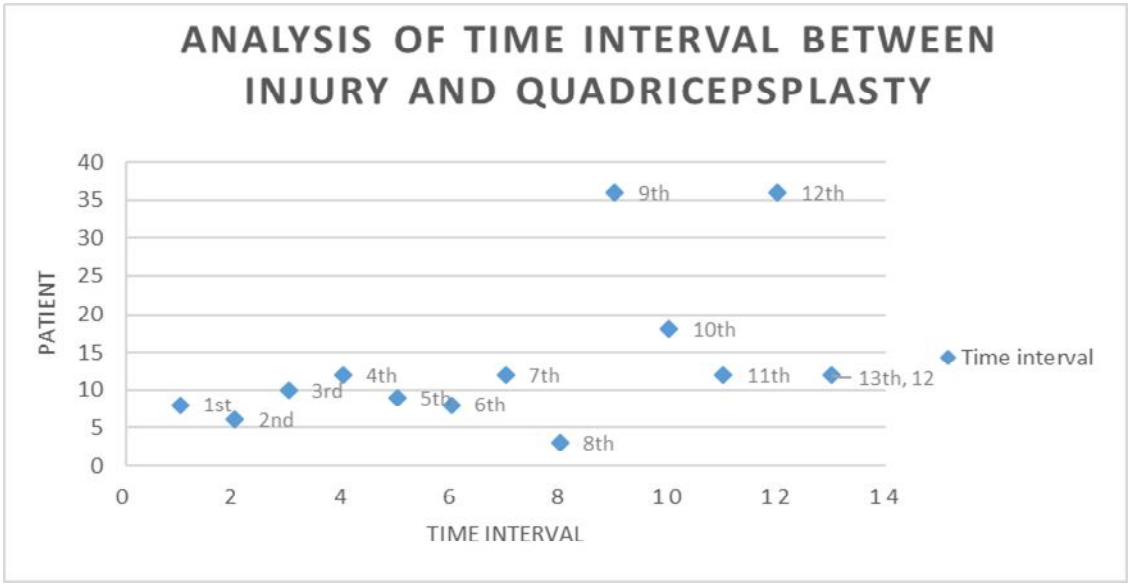
8) **Postoperative complications**

Method	**Number of cases**	**Extension lag**	**Wound complication**
Judets	7	0	0
Thompson	4	1	0
V-y plasty	2	2	1



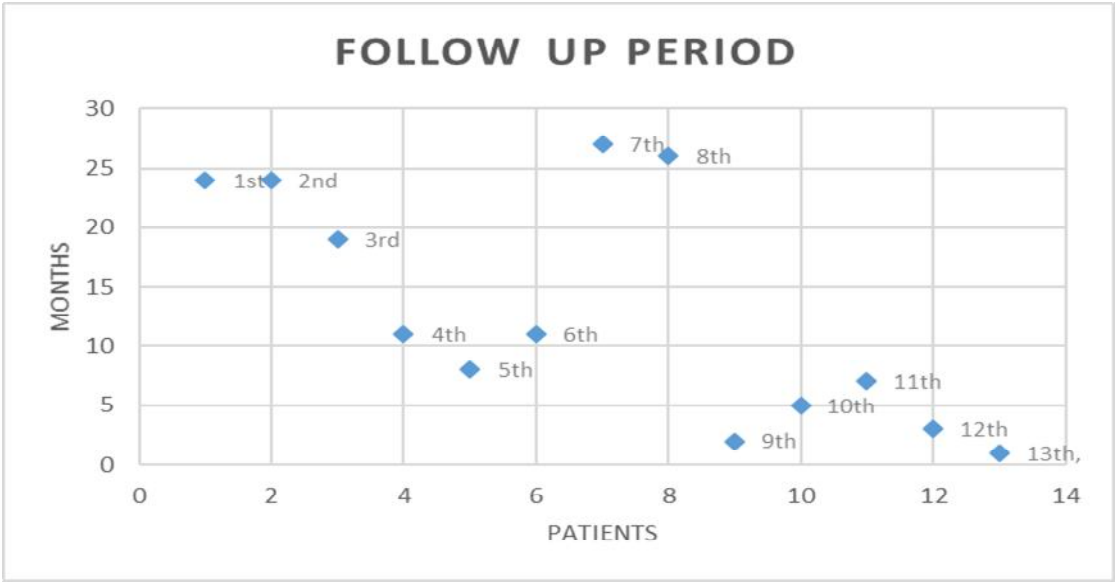
In our study Judet's technique has no complications, extension lag is noted in 1 case of Thompson and 2 case of V-Y plasty. Postoperative granulating wound over knee joint is noted in 1 case of V-Y plasty.

9) Analysis of time interval between injury and quadricepsplasty



In our study the mean time interval between injury and quadricepsplasty is 14 months .

10) Period of follow up



In our study the mean follow up period after quadricepsplasty is 14 months with minimum follow up of 1 month and maximum of 27 months.

DISCUSSION

Quadricepsplasty is a technique of releasing extra articular and intra articular adhesions / contractures which restores useful flexion of the knee joint. Massive soft tissue injury of the anterior thigh , intramuscular injections in the anterior thigh ,lengthening procedures involving the femur and other congenital causes of short rectus femoris are all proposed as the possible causes of extension contracture of the knee joint.

Judet[4] reported 53 cases in 1959 out of which 45 cases(84.90%) are posttraumatic.The remaining causes were secondary to arthritis, prolonged immobilisation and patellectomy.

Similarly in our study all cases were observed to be posttraumatic most commonly periarticular fractures of distal femur.

Many procedures have been described in the literature for treatment of extension contracture of the knee joint .In our study we have analysed the outcome of three techniques of quadricepsplasty namely thompson, Judet , V- Y lengthening quadricepsplasty of rectus femoris.

An inherent risk of Thompson quadricepsplasty is the possibility of developing extension lag due to insufficient power of rectus femoris to oppose the hamstings or to maintain extension at the knee as it takes the body weight when walking .

Moore et al reviewed nine patients of Thomson quadricepsplasty and reported six cases of mean extension lag of 10° which amounts to 66.66% of patients.[26]

Contrary to literature in our study 25% of patients who underwent Thompsons technique developed extension lag of 10° . Although further follow up study is needed to evaluate our observation.

Nicoll et al reported 30 patients with an average flexion of 68° . In his study 6 patients required lengthening of the rectus femoris muscle and these patients had permanent extension lag with the range of 20° - 40°. [3]

In our study 2 patients had undergone lengthening of rectus femoris in the form of V-Y Plasty , these 2 patients developed extension lag which is comparable to the literature.

The results of 53 quadricepsplasty done by *Judet* [4] showed that 11% had extension lag and the majority cases had maximum flexion beyond 100° . In our study 7 patients had undergone Judets

quadricepsplasty the average peroperative knee flexion achieved is 102.85° and the postoperative flexion is 75.71° which is significantly less compared to original judet's technique.

This is attributed to lack of vigorous postoperative mobilisation exercises and lack of motivation due to severe pain in the immediate postoperative period. There was no extension lag reported in our study who underwent Judets technique .

Z S Kundu et al [19] reported average loss of flexion of 11° post operatively compared to intra operative period . In our series we had average loss of flexion of 13.84° which is again significantly higher than the literature attributed to lack of aggressive physiotherapy.

H.Daoud et al in his series of six cases who underwent judet quadricepsplasty had encountered difficulty in achieving satisfactory flexion in 50% of patients for which he releases the rectus femoris from its origin with no postoperative extension lag.**[6]**

In our series 14.2% of patient who underwent judet's quadricepsplasty required rectus femoris release and there is no

postoperative complications in the form of extension lag which is comparable to the literature.

The advantage of Judet technique is that it permits controlled and sequential release of the quadriceps components limiting the knee flexion. The dissection can be stopped at any phase of the procedure if the flexion obtained is adequate. Moreover in Judet's procedure unlike thompsons vastus medialis is not much disturbed which plays only accessory role in extension contracture.

Further the contractures and fibrosis of the quadriceps is addressed by proximal release of the muscles rather than distal lengthening procedure as done in Thompson's technique . Because of these reasons the potential for iatrogenic extension lag is reduced in Judet's technique .

Another complication that is frequently encountered is post operative wound dehiscence,that are frequently cumbersome to treat alongside knee mobilisation exercises .

S.B Hahn et al in his series of 20 cases who underwent modified Thomson quadricepsplasty reported 1 case of wound complication that resolved after intravenous antibiotics and debridement. In our series there were no postoperative wound complication in Thompson and judet's technique, only one patient who underwent V-Y lengthening had

postop wound in the form of granulating 1cm×1cm wound over the anterior aspect of knee joint.

Postoperative wound complication is implicated to the location of the incision in the anterior aspect of knee often leading to skin sloughs,hypertrophic scar and wound breakdown.

In our study before the operation all 13 patients had no complaints of knee pain , post operatively all of them encountered severe pain hindering post operative knee mobilisation and thus leading to loss of flexion obtained per operatively . This can be managed by judicious use of analgesics in the form of epidural catheter and intravenous analgesia . The pain was found to gradually reduce at subsequent followups and all the patients were eventually relieved of knee pain.

Hnevkovsky et al reported 70% good ,30% fair results according to judet's criteria. In our study the Judet's criteria is "good" in 61.53 %, fair in 30.76 % and excellent in 7.69% patient which is comparable to the study.

LIMITATION

There are few limitation in our study

1)small sample size

2) short follow up period.

3)non comparison of individual techniques.

CONCLUSION

Quadricepsplasty is undoubtedly one of the rewarding procedures in orthopaedics that improves quality of life and functional outcome in stiff knee. Judets technique had fewer postoperative complications compared to other techniques. Aggressive postoperative physiotherapy plays a vital role in achieving good results in quadricepsplasty.

Case illustrations

Case 1

Mr yuvaraj 29/M Ip no 63344

Diagnosis:3 year old united fracture shaft of femur with stiff knee.

Procedure done:Judet's quadricepsplasty

Preop knee flexion	20°
Perop knee flexion	110°
Postop knee flexion	90°
Gain of flexion	70°
Extension lag	Nil
Wound complication	Nil
Judets score	Good
Time interval between injury and mobilisation surgery	3 years
Duration of follow up	3 months

Preop photo knee flexion 20°

Perop photo knee flexion 110°

1month follow up -90°flexion

Knee bending with weight bearing at 3 months

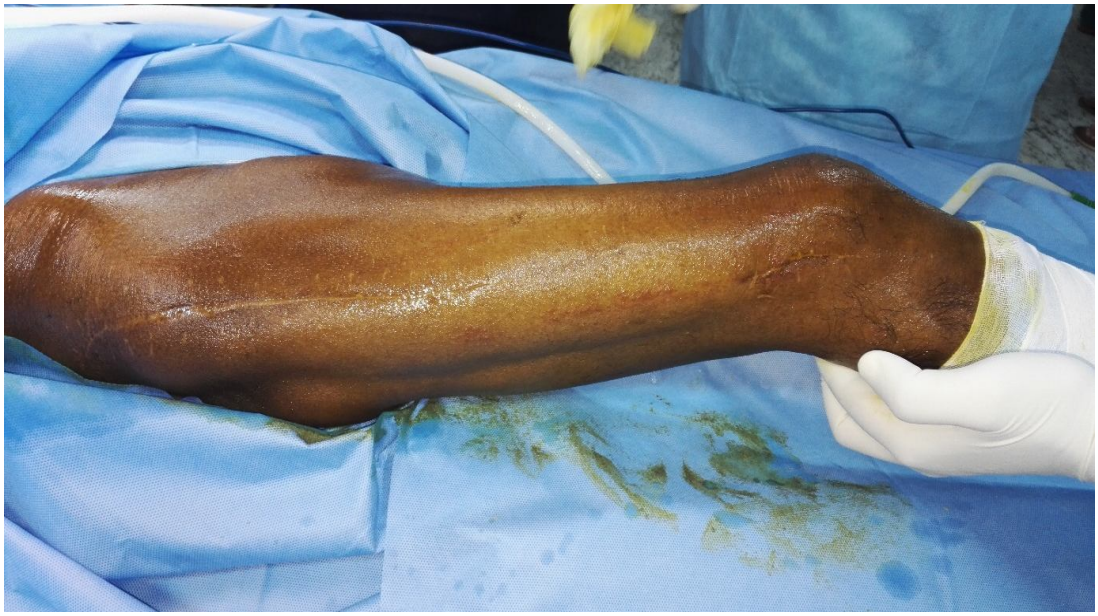
Case 2

Mr.Mani 55/M Ip no:74146

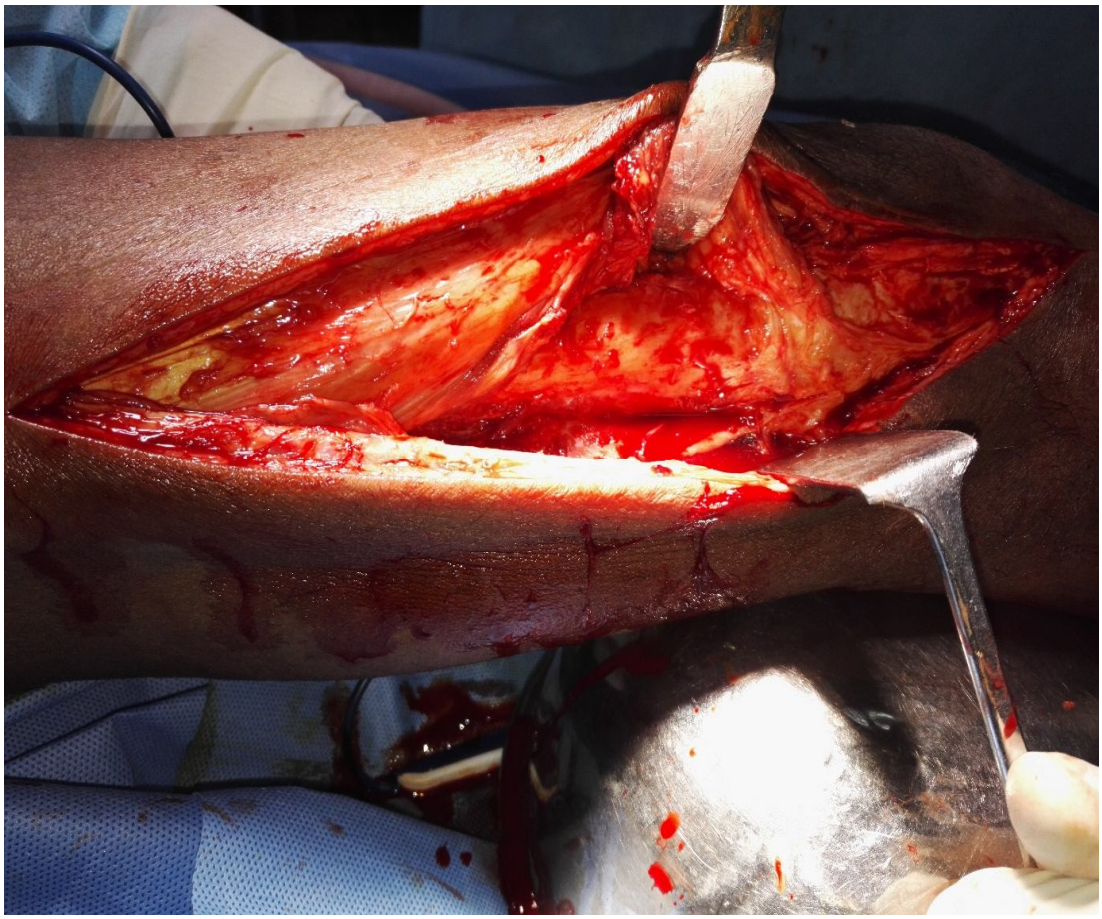
Diagnosis:3 year old united segmental fracture shaft of femur with Proximal femoral nail insitu.

Procedure done : Implant exit and Judet's quadricepsplasty.

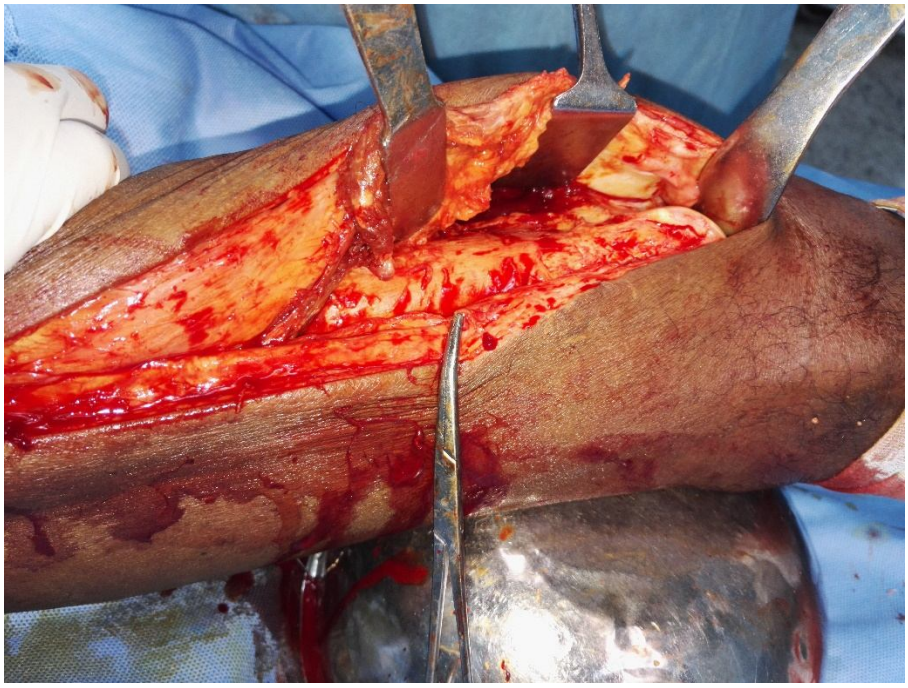
Preop knee flexion	20°
Perop knee flexion	110°
Postop knee flexion	70°
Gain of flexion	50°
Extension lag	Nil
Wound complication	Nil
Judets score	Fair
Time interval between injury and mobilisation surgery	3 years
Duration of follow up	2 months



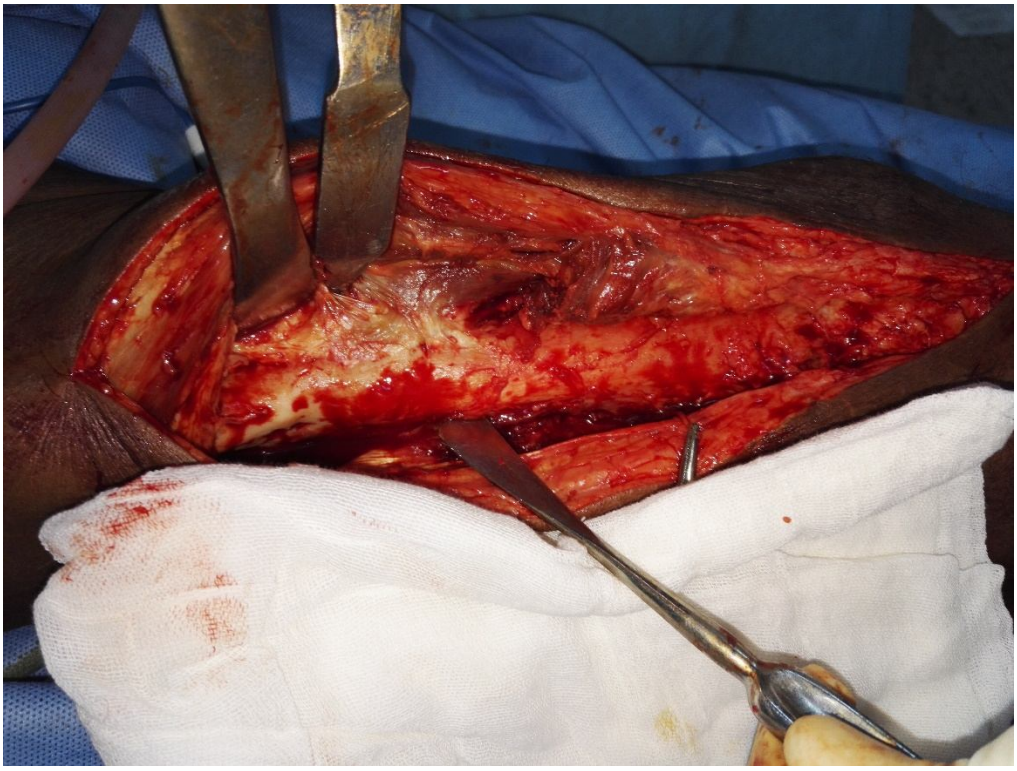
Perop photo knee flexion 20°



Adhesions between vastus intermedius and femoral condyle and release of lateral retinaculum in the knee joint



After release of vastus intermedius



Adhesion at fracture site between vastus intermedius and femur at fracture site

Release of vastus lateralis, vastus intermedius rectus femoris (knee flexion 100°).

2 month follow up knee flexion 70°

Case 3

Mr.Ravi 36/M Ip no:115824

Diagnosis:8 month old united supracondylar fracture femur right side with LCP insitu with stiff knee

Procedure done : Judet's quadricepsplasty

Preop knee flexion	10°
Perop knee flexion	110°
Postop knee flexion	90°
Gain of flexion	80°
Extension lag	Nil
Wound complication	Nil
Judets score	Good
Time interval between injury and mobilisation surgery	11 months
Duration of follow up	11 months

11 month postop knee flexion 90°

Case 4

Mr.Karunakaran 30/M IP No : 68019

Diagnosis:1 ½ year old posterior dislocation knee with stiff knee

Procedure done: Arthroscopic arthrolysis and V-Y Plasty

Preop knee flexion	10°
Perop knee flexion	110°
Postop knee flexion	100°
Gain of flexion	90°
Extension lag	40°
Wound complication	Non healing ulcer over anterior aspect of knee
Judets score	Excellent
Time interval between injury and mobilisation surgery	1 years
Duration of follow up	7 months

Knee flexion 110°

Non healing wound in V-Y quadricepsplasty after 7 month follow up

Bibliography

1. George E Bennett .Lengthening of quadriceps tendon .J.Bone Joint Surg .,1922,4,279-281

2. Thompson T C .Quadricepsplasty to improve knee function. J.Bone Joint Surg .,1944,26-A,366-378

3. Nicolle EA. Quadricepsplasty. Postgrad .Med J.(1964),40,521

4. Judet R,Mobilisation of the stiff knee .J.Bone joint Surg[Br] 1959 :41-B:856-7

5. K. T. Hesketh . Experiences with the Thompson quadricepsplasty Vol 45 B,491-495

6. H Daoud et al .Quadricepsplasty .J.Bone Joint Surg[Br]1982, Vol 64 B,194-197

7. Kettlekamp et al .An electrogoniometric study of knee motion in normal gait. J.Bone Joint Surg 1970; 52-A;775-90

8. J.Bellemens et al. The judet quadricepsplasty : A retrospective Analysis of 16 cases. Acta orthopaedica Belgica.vol 62-2-1996 79-82

9. Sengupta S: Pathogenesis of infantile quadriceps fibrosis and its correction by proximal release, J Pediatr Orthop 5:187, 1985

10. Santo S, Kokubun S. Report of the diagnosis and treatment of muscular contracture, J Jpn Orthop Assoc 59:223, 1985.

11. Hnevkovsky O.Progressive fibrosis of the vastus intermedius muscle in children.J Bone Joint Surg Br.1961;43;318-25.

12. Fairbank and Barrett, 1961. Fairbank TJ, Barrett AM: Vastus intermedius contracture in early childhood. J Bone Joint Surg 1961; 43B:326.

13. Nozawa et al., 2004. : Congenital contracture of the quadriceps muscle: a case report with magnetic resonance imaging. Arch Orthop Trauma Surg 2004; 124:272

14. Jackson and Hutton, 1985. : Injection-induced contractures of the quadriceps in childhood: a comparison of proximal release and distal quadricepsplasty. J Bone Joint Surg 1985; 67B:97.

15. Sasaki et al., 1985. Postoperative evaluation of quadriceps contracture in children: comparison of three different procedures. J Pediatr Orthop 1985; 5:702.

16. Lloyd-Roberts and Thomas, 1964. Lloyd-Roberts GC, Thomas TG: The etiology of quadriceps contracture in children. J Bone Joint Surg 1964; 46B:498.

17. S.B.Hahn et al . 2000. A modified Thomson Quadricepsplasty for Stiff knee .J.Bone Joint Surg,Br.2000;82B,992-5

18. H.S.Hosalkar et al.Quadricepsplasty for knee stiffness after Femoral lengthening in congenital short femur. J.Bone Joint Surg Vol 85-B,No-2,March 2003

19. Z.S.Kundu et al. Thompson Quadricepsplasty for stiff knee. Indian J.Orthop 2007;oct-dec,41(4);390-394

20. Saurabh khakharia et al.Limited quadricepsplasty for contractures during femoral lengthening.Springer 2009,467;2911-2917

21. YU Chi Huang et al. Modified Thompson quadricepsplasty to treat Extension contractures of the knee after surgical treatment of patellar Fractures . Chang Gung Med J 2007;30;263-9

22. M.A.Fiogbe et al .Distal quadricepsplasty in children :88 cases of retractile Fibrosis following intramuscular treated in benin. Orthopaedics & Traumatology :Surgery & research 2013;99,817-822

23. Bari MM et al .Judet's quadricepsplasty for extension contracture of the Knee(stiff knee). MOJ Orthopaedics & Rheumatology 2015.2(6):1-6

24. Wang et al., 2007. Wang JH, Zhao JZ, He YH: A new treatment strategy for severe arthrofibrosis of the knee. Surgical technique. J Bone Joint Surg 2007; 89A(suppl 2):93.

25. F.S Sutton et al,1976 . The effect of patellectomy on knee function J Bone Joint Surg. VOL. 58-A, NO. 4, JUNE 1976 .

26. Moore et al. The results of quadricepsplasty on knee motion following femoral fractures. J trauma ,1987,27:49-51

Annexures

PROFORMA

Outcome analysis of quadricepsplasty in stiff knee

Name : Age/sex: IP number :

Address with contact number:

Diagnosis :

Date of admission :

Date of surgery :

Date of discharge :

Mode of injury :

Cause of stiff knee :

Preop range of Movement :

Presence of Extension lag : Yes / No

Union of Fracture : Yes / No

Pre operative plan :

Per operative range of movement :

Post operative range of movement :

Post operative gain of flexion :

Post operative loss of flexion :

Time interval between injury & surgery:

Period of follow up :

Duration of CPM given :

Post operative wound complication : Yes / No

Postoperative Extension lag : Yes / No

Judet's Criteria :

PATIENT CONSENT FORM

Study Detail : **OUTCOME ANALYSIS OF QUADRICEPSPLASTY IN STIFF KNEE**

Study Centre : Rajiv Gandhi Government General Hospital, Chennai.

Patient's Name :

Patient's Age :

Identification Number :

Patient may check (√) these boxes

a) I confirm that I have understood the purpose of procedure for the above study. I have the opportunity to ask question and all my questions and doubts have been answered to my complete satisfaction. ☐

b) I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected. ☐

c) I understand that sponsor of the clinical study, others working on the sponsor's behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records, both in respect of current study and any further research that may be conducted in relation to it, even if I withdraw from the study I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study. ☐

d) I agree to take part in the above study and to comply with the instructions given during the study and faithfully cooperate with the study team and to immediately inform the study staff if I suffer from any deterioration in my health or well being or any unexpected or unusual symptoms. ☐

e) I hereby consent to participate in this study. ☐

f) I hereby give permission to undergo detailed clinical examination, Radiographs & blood investigations as required. ☐

Signature/thumb impression Signature of Investigator

Patient's Name and Address: Investigator's Name:

Judet’s criteria

Criteria	Amount of postoperative flexion
Excellent	>100°
Good	80° – 100°
Fair	50° – 79°
Poor	<50°

INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI 600 003

EC Reg.No.ECR/270/Inst./TN/2013
Telephone No.044 25305301
Fax: 011 25363970

CERTIFICATE OF APPROVAL

To
Dr.Gnanavinayagan.S.,
Post Graduate in M.S. Orthopaedic Surgery
Madras Medical College
Chennai 600 003

Dear Dr.Gnanavinayagan.S.

The Institutional Ethics Committee has considered your request and approved your study titled **"OUTCOME ANALYSIS OF QUADRICEPSPLASTY IN STIFF KNEE "- NO. 15042016.**

The following members of Ethics Committee were present in the meeting hold on **05.04.2016** conducted at Madras Medical College, Chennai 3

1.Dr.C.Rajendran, MD.,	:Chairperson
2.Dr.Isaac Christian Moses,MD.Ph.D.Dean(FAC)MMC,Ch-3	:Deputy Chairperson
3.Prof.Sudha Seshayyan,MD., Vice Principal,MMC,Ch-3	: Member Secretary
4.Prof.B.Vasanthi,MD., Prof.of Pharmacology.,MMC,Ch-3	: Member
5.Prof.P.Raghumani,MS, Prof. of Surgery,RGGGH,Ch-3	: Member
6. Prof.Md.Ali,MD.,DM.,HOD-MGE, MMC,Ch-3	: Member
7.Prof.Baby Vasumathi, Director, Inst. of O&G,Ch-8	: Member
8.Prof.K.Ramadevi,MD, Director,Inst.of Bio-Chem,MMC,Ch-3	: Member
9.Prof.M.Saraswathi,MD.,Director, Inst.of Path,MMC,Ch-3	: Member
10.Prof.Srinivasagalu,Director,Inst.of Int.Med.,MMC,Ch-3	: Member
11.Tmt.J.Rajalakshmi, JAO,MMC, Ch-3	: Lay Person
12.Thiru S.Govindasamy, BA.,BL,High Court,Chennai	: Lawyer
13.Tmt.Arnold Saulina, MA.,MSW.,	:Social Scientist

We approve the proposal to be conducted in its presented form.

The Institutional Ethics Committee expects to be informed about the progress of the study and SAE occurring in the course of the study, any changes in the protocol and patients information/informed consent and asks to be provided a copy of the final report.

Member Secretary – Ethics Committee

MEMBER SECRETARY
INSTITUTIONAL ETHICS C
MADRAS MEDICAL COL
CHENNAI-600 003

turnitin

Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

The first page of your submissions is displayed below.

Submission author:	221412001 Ms Ortho Gnanavinaya...
Assignment title:	2015-2015 plagiarism
Submission title:	outcome analysis of quadricepspla...
File name:	thesis_final_plagiri28.docx
File size:	12.08M
Page count:	83
Word count:	6,574
Character count:	36,490
Submission date:	06-Oct-2016 11:11PM
Submission ID:	714886251

DISSERTATION ON

OUTCOME ANALYSIS OF QUADRICEPSPLASTY IN OSTEOSAR

SUBMITTED TO

THE TAMILNADU

DR.M.G.R. MEDICAL UNIVERSITY

CHENNAI, TAMILNADU

In Partial Fulfillment of the regulations

for the award of the degree of

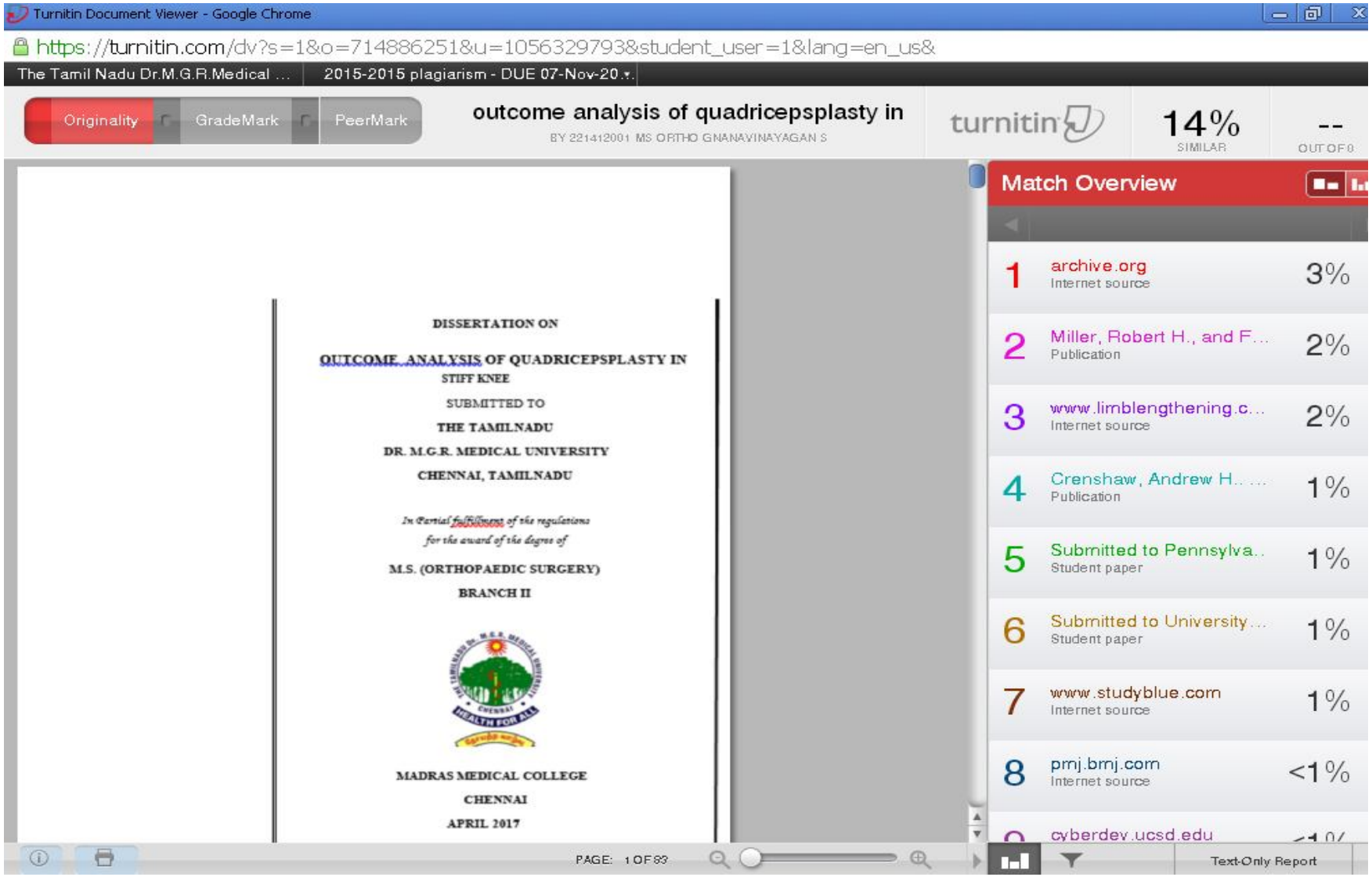
M.S. (ORTHOPAEDIC SURGERY)

BRANCH II

MADRAS MEDICAL COLLEGE

CHENNAI

APRIL 2017


Turnitin Document Viewer - Google Chrome
https://turnitin.com/dv?s=1&o=714886251&u=1056329793&student_user=1&lang=en_us&
The Tamil Nadu Dr.M.G.R.Medical ...
2015-2015 plagiarism - DUE 07-Nov-20...
Originality
GradeMark
PeerMark
outcome analysis of quadricepsplasty in
BY 221412001 MS ORTHO GNANAVINAYAGAN S
turnitin
14%
SIMILAR
--
OUT OF 0
DISSERTATION ON
OUTCOME ANALYSIS OF QUADRICEPSPLASTY IN STIFF KNEE
SUBMITTED TO
THE TAMILNADU
DR. M.G.R. MEDICAL UNIVERSITY
CHENNAI, TAMILNADU
In Partial fulfillment of the regulations
for the award of the degree of
M.S. (ORTHOPAEDIC SURGERY)
BRANCH II
MADRAS MEDICAL COLLEGE
CHENNAI
APRIL 2017
PAGE: 1 OF 83
Match Overview
1 archive.org Internet source 3%
2 Miller, Robert H., and F... Publication 2%
3 www.limblengthening.c... Internet source 2%
4 Crenshaw, Andrew H.. ... Publication 1%
5 Submitted to Pennsylva.. Student paper 1%
6 Submitted to University... Student paper 1%
7 www.studyblue.com Internet source 1%
8 pmj.bmj.com Internet source <1%
cyberdev.ucsd.edu
Text-Only Report

MASTER CHART

S.No	Patient name	Age/sex	IP No	Method	Mode of Injury	Follow up Period (month)	Time interval between injury &surgery	Range of Movement			Gain of flexion	Extension lag	Remark
								Pre op	Per op	Post op			
1	Mr.Chellakannu	29/M	81148	J	RTA	24	8month	10°	110°	90°	80°	Nil	Good
2	Mr.Victor	29/M	92930	J	RTA	24	6month	10°	90°	50°	40°	Nil	Fair
3	Mr.Jagadessan	29/M	5458	T	RTA	19	10month	20°	110°	90°	70°	Nil	Good
4	Mr.Natarajan	28/M	121337	J	RTA	11	1year	20°	100°	70°	50°	Nil	Fair
5	Mr.Saikrishna	35/M	122498	T	RTA	8	9month	10°	110°	90°	90°	Nil	Good
6	Mr.Ravi	36/M	115824	J	RTA	11	8month	10°	100°	90°	80°	Nil	Good
7	Mr.Kannan	30/M	122078	J	RTA	27	1year	20°	110°	70°	50°	Nil	Good
8	Mr.Ramesh	30/M	21345	T	RTA	26	3month	10°	110°	80°	70°	Nil	Good
9	Mr.Mani	55/M	74146	J	RTA	2	3year	20°	100°	70°	50°	Nil	Fair
10	Mr.Gopi	25/M	34642	T	RTA	5	$1_{1/2}$ year	20°	110°	90°	70°	10°	Good
11	Mr.Karunakaran	30/M	68019	V-Y Plasty	RTA	7	1year	10°	110°	100°	90°	40°	Excellent
12	Mr.Yuvaraj	29/M	63344	J	RTA	3	3year	20°	110°	90°	70°	Nil	Good
13	Mr.Velu	25/M	91098	V-Y Plasty	RTA	1	1year	10°	90°	60°	50°	10°	Fair